PL²

http://personalizedlearning2.org/

Building Resources for a Personalized Learning Mentor App: A Design Case

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Inception

Barriers to Success
No one-size-fits-all solution

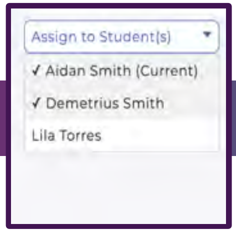
Personalized Learning²
Help mentors help (whole) students

V1.0

Resource List
List of internet links, organized by strategy; can only assign to 1 student at a time

V1.x

Create Your Own
Tap into mentors' expertise



Can Assign to >1
Save mentors time

Activities
Includes brief description, intended use, instructions, and prompts

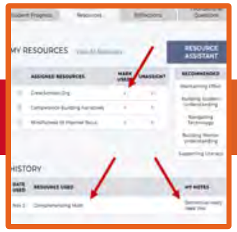
Additional Strategies
Based on feedback from mentors

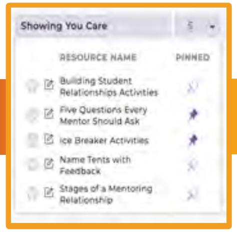
V2.0

Organizing Resources
Status>Strategy>Category>Resource

Resource Assistant
Questions map to categories

Marking as Used
Mark when resource is used; add optional note





Pinning Resources
Pin favorites or to read later

Next Steps...

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Chan Zuckerberg Initiative

Building Strategies for a Personalized Learning Mentor App: A Design Case

Objectives

High levels of mathematical competence are an increasingly central requirement for high-paying careers in the 21st century (Rose & Betts, 2004). Racial and economic opportunity gaps are preventing millions of American students from realizing their potential, and this perpetuates inequalities of income and opportunity across generations (Autor, 2014). While these are long-standing problems, researchers have struggled to identify effective solutions. However, recent research undertaken in the Chicago Public Schools, in some of Chicago's highest-poverty neighborhoods, provides new grounds for hope (Cook et al., 2015; Guryan et al., 2017). Using a high-quality randomized control trial with a large number of students, they demonstrated that just one year of intensive, personalized tutoring could narrow racial achievement gaps in mathematics by as much as one third. Unfortunately, these gains came at a substantial resource cost; with one tutor providing instruction to just two students per class period, the costs exceed the threshold of feasibility in many districts.

Fortunately, advances in computer-aided learning may provide a method of substantially lowering the cost of personalized tutoring while maintaining the magnitude of the learning gains. Research on AI-driven, computer-based tutoring has shown that computer tutors can substantially accelerate student learning, especially in mathematics (Koedinger et al., 1997). Although computer tutors can provide effective support for student thinking and learning, these systems do not provide human support for development in areas such as self-efficacy building (Siegle et al., 2007), feelings of belonging (Walton & Cohen, 2011), growth mindset (Yeager & Dweck, 2012), and valuing utility of STEM (Harackiewicz et al., 2016).

This design case is part of a larger project funded by a grant through the Chan

Zuckerberg Initiative (CZI). The project combines human tutoring and mentoring relationships with the power of AI-driven learning systems to substantially advance the learning of disadvantaged students, especially in mathematics. Thus, we created an AI-based tutoring support system, *personalized^2* (PL^2), aimed at reaping similar benefits to Cook et al. (2015) and Guryan et al. (2017) with significantly lower manpower and cost requirements. For this design case, we will describe the iterative design behind the creation of a resource library of strategies for mentors to use to help their students. Specifically, we will report results from the preliminary stages of a design case, as well as future steps for ongoing redesign.

Project Description

At the core of this project is an effort to maximize the motivational capability of human mentors and the ability of computer-aided learning systems to provide personalized learning at low cost, with the aim of substantially reducing income and racial gaps in learning opportunities and outcomes. We engaged stakeholder co-design with district partners who were already using existing AI-driven computer tutors to determine the level and nature of human mentoring that is most productive in achieving our goals. For this, we built a data-feedback infrastructure that works with existing educational technology products to provide qualitative and quantitative feedback on student learning opportunities and longer-term achievement gains from benchmark assessments. Data-driven design was coupled with qualitative design research to understand user needs. To enhance face-to-face professional development, we also implemented interactive learning support for mentors and teachers to focus on skills for real-time use of social-motivational strategies.

Our design was built on a school-driven strategy to identify root causes of learning opportunity gaps that can be addressed through collaboration between university and school researchers, educators, and community leaders. Based on these results, we recruited four district partners interested in using the PL^2 app in different contexts. In district-specific meetings, we co-designed situated versions of the innovations to adjust to their priorities, existing initiatives, conditions, assets, and needs. Each district has existing sources of mentors or will begin engaging mentors in Summer 2019. The different types of mentors include undergraduate mentoring fellows (District 1), instructional specialists (District 2), AmeriCorp tutors and parents (District 3), and classroom teachers (District 4). We adapted to different software usage, as well as different grades across districts (see Table 1 for an overview). We supplemented existing professional development by adding modules in use of adaptive technologies, tutoring methods, and social-emotional and culturally sustaining approaches.

Our design and development team consists of faculty members, postdocs, undergraduates, research scientists, and software developers with a wide range of expertise including computer science, human-computer interaction, learning sciences, educational psychology, anthropology, and math education. Throughout this project, we engaged in many participatory design activities with our district partners. Community- and network-building meetings among the partners occurred through monthly Web conferences and quarterly all-project meetings. We created additional routines and will continue to find opportunities to support the creation of a collaborative community. This included networking and trust-building opportunities; creating a shared understanding and establishing practices to support participatory research, design, and development; deepening our collective understanding of regional opportunity gaps; and developing culturally responsive practices, relationships, and resources. In addition to these remote meetings, we also met face-to-face during a semi-annual retreat with all partners; codesign meetings, focus groups, and interviews with the mentors and site administrators; and observations of mentors in practice.

Design Decisions

Word count restrictions preclude a full, thick description of all design decisions. Therefore, we focus on the three most salient decisions to date: building a library of resources, personalizing the resources to the mentor, and the introduction of a strategy wizard. For this, we discuss the inception, design process, and use (Boling, 2010), as well as next steps.

Inception

Our initial interviews and community interactions led to a broad set of interdependent enabling conditions for student success (Figure 1). We heard experiences suggesting root causes across this whole spectrum related to home/economic conditions, school conditions, social/motivational conditions, and cognitive/content conditions. If limitations in student success were due to one or a few conditions, a relatively simple and general solution would be possible. That no simple and general school improvement solution has emerged despite years of effort suggests this premise is wrong. Further, our interviews and community discussions produced no simple consensus around a single, central problem. The clear message was that the challenges students face are widely and evenly distributed. Thus, a key to our approach was to develop a data feedback infrastructure to help schools and researchers work together to identify the right solutions for the right problems. Different students face many different challenges, so a one-size-fits-all solution would not work. Instead, an ideal learning solution must be adaptive to the personal needs of each child. We identified particular opportunities to enhance the personalized learning support within our participating districts. A key premise of our project was that personalization must address both the socio-emotional conditions and the cognitive/content conditions.

Design Process

Based on our findings from our interviews, we decided to collect a wide range of cognitive and social-emotional support resources. We turned to researchers, teachers, and other stakeholders to source a wide collection of research articles, handbooks, videos, and guides aimed at different enabling conditions identified in the preliminary investigation. Using our findings from the interviews and previous research and theory (e.g., Harackiewicz et al., 2016), we created 12 initial categories of resources to classify each of the resources we collected. Our goal was to organize our library of resources so that mentors could access the most appropriate strategy based on the students' given needs. We incorporated these stratified resources into the first iteration of the app (see Figures 2, 3, and 4; all names are pseudonyms).

Use

Through feedback from mentors and the site administrators, we learned about multiple challenges related to the resources. First, there were technological limitations that interfered with successful use of the app. For example, at one site, the mentors did not have internet access and could not use the app during the tutoring sessions. As many of the resources were videos or activities that needed student participation, this became an issue. Second, mentors seemed overwhelmed by the resources available. Despite the categories, the mentors found it difficult to know which strategies to use. As seen in Figure 3, mentors had to choose resources from a dropdown menu and might have not understood the meaning of all resource labels. Once they chose from the list, they were again presented with a list (see Figure 4), without a clear description of each activity. Moreover, many resources were presented in primary source format, and as a result were often too long and dense for mentors to read, process, and implement in one planning session. For example, in Figure 4, all three Growth Mindset resources are links to websites, varying in length and time commitment. Finally, the mentors noted several new categories that were needed to help students. For example, mentors needed literacy strategies for students who were struggling to comprehend long word problems. Some mentors also needed help with the math content, as mentors at some sites are not required to have a background in math or math education.

Next Steps

From the results in the use stage, we realized that we need to address three key issues moving forward. First, we need to continue to build our library of resources, incorporating new categories that will help mentors address students' needs. Next, we need to build in components that allow the mentors to tailor the resources to meet their own and the students' preferences, abilities, and mentoring contexts. For this, we will build out multiple components from each resource, including a brief summary of the topic behind the resource, activity (i.e., with the student), task (i.e., without the student), primary source, and vignette (i.e., story of how the resource has been successfully implemented). We will design these so that some of them can be used just-in-time with the students or during planning or reflection before or after the session, respectively. Finally, we need to create a strategy wizard that will help guide the mentors through a series of questions to arrive at the most appropriate strategy for the students' current needs. After our first implementation, we increased our team to include two postdocs and an undergraduate design major. The major responsibility of these new team members was to design and build out the resources in a user-friendly interface on the app. Thus far, we have begun each of these three improvements to the app (see Figures 5 and 6) and will finish our initial library of newly designed resources in time for the next round of implementation in Fall 2019.

Significance

This design case demonstrates our attempts at creating strategies for a mentoring app within four unique contexts. It highlights our struggles and successes in finding, shaping, and disseminating resources for mentors to help students learn math better online, while also addressing other cognitive, motivational, and emotional issues, in an attempt to narrow the existing opportunity gap. Our design case provides insight into working on large, diverse teams, addressing the needs of different users in various contexts, and the integration of rapid iterations based on both quantitative and qualitative data. Future designers may benefit from this design process of identifying needs, developing resources, diagnosing weaknesses, and redesigning across a large, interdisciplinary team.

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Table 1

Overview of Project by District

District	Educational Technology	Grades	Type(s) of Mentor	Mentoring Sessions
1	Mathia	6-8	Undergraduate Fellows	After school
2	Mathia	6-12	Instructional Specialists	In school
3	Multiple	4-12	AmeriCorps, Parents	In school, at home
4	ESpark, Wowzers, Mathia	K-12	Teachers	In school

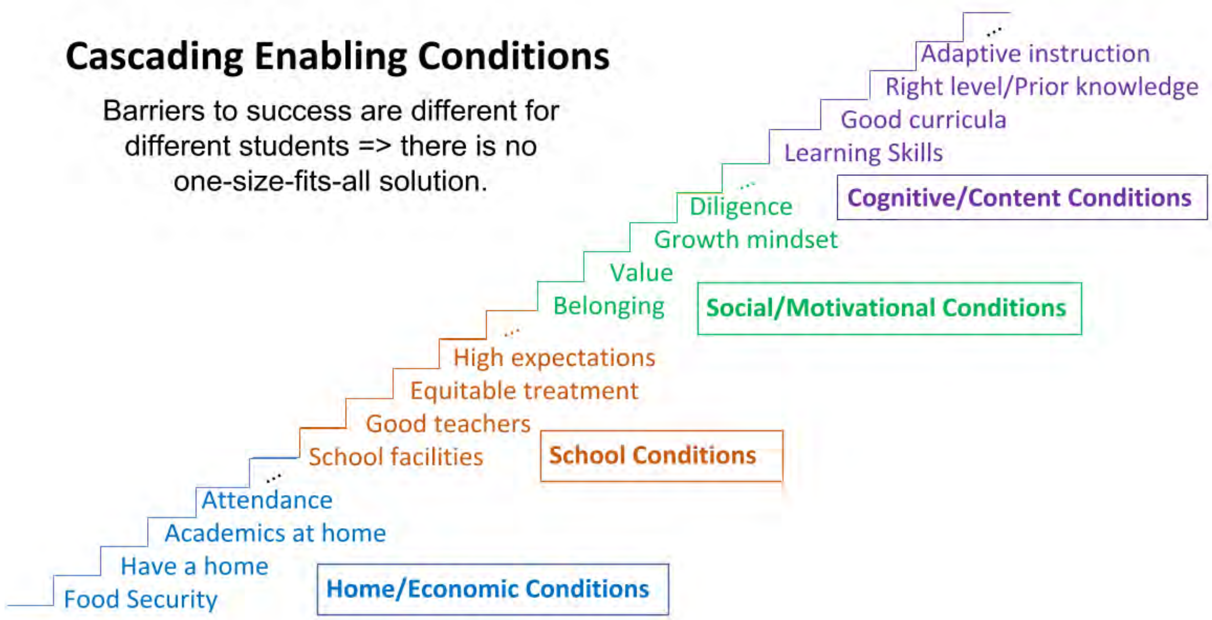

Figure 1. Emergent Themes from Interviews with Stakeholders

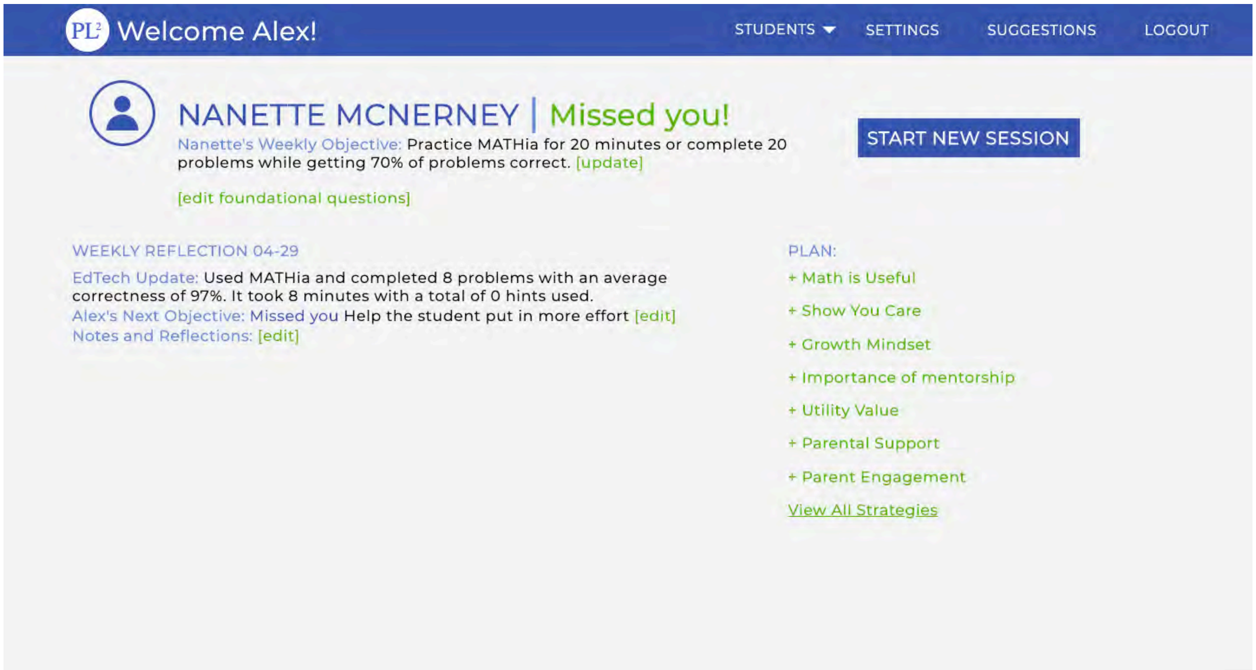

Figure 2: Original mentor page in PL^2 app

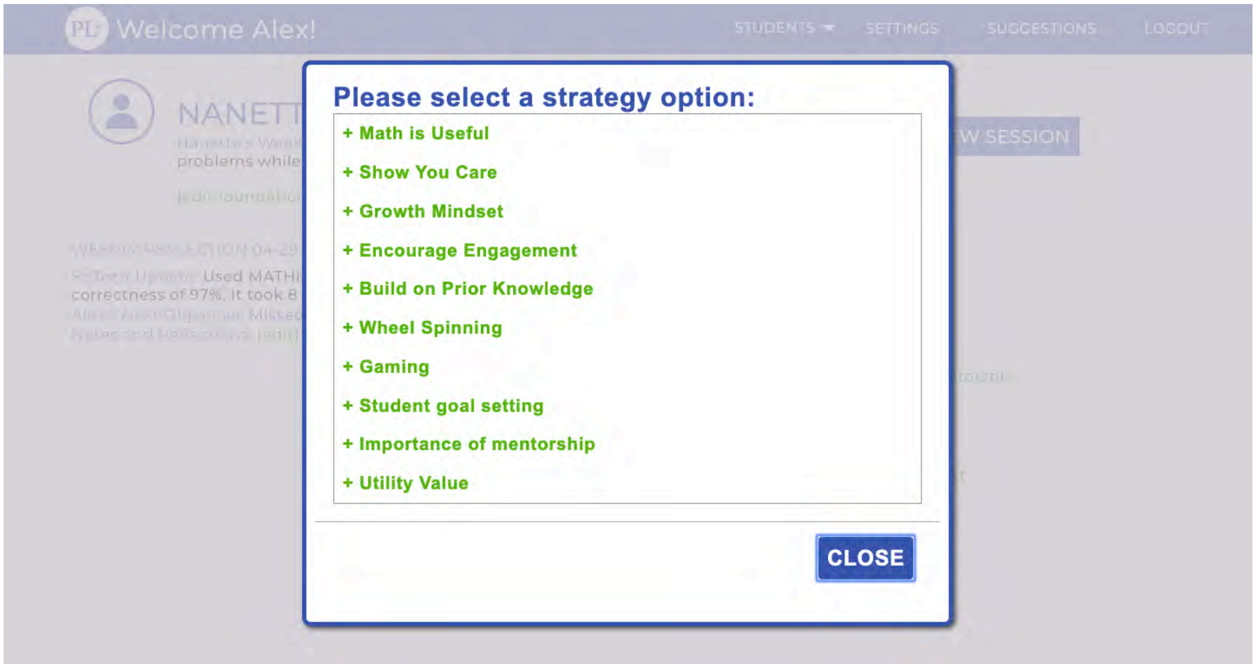

Figure 3: Original option to view all strategies

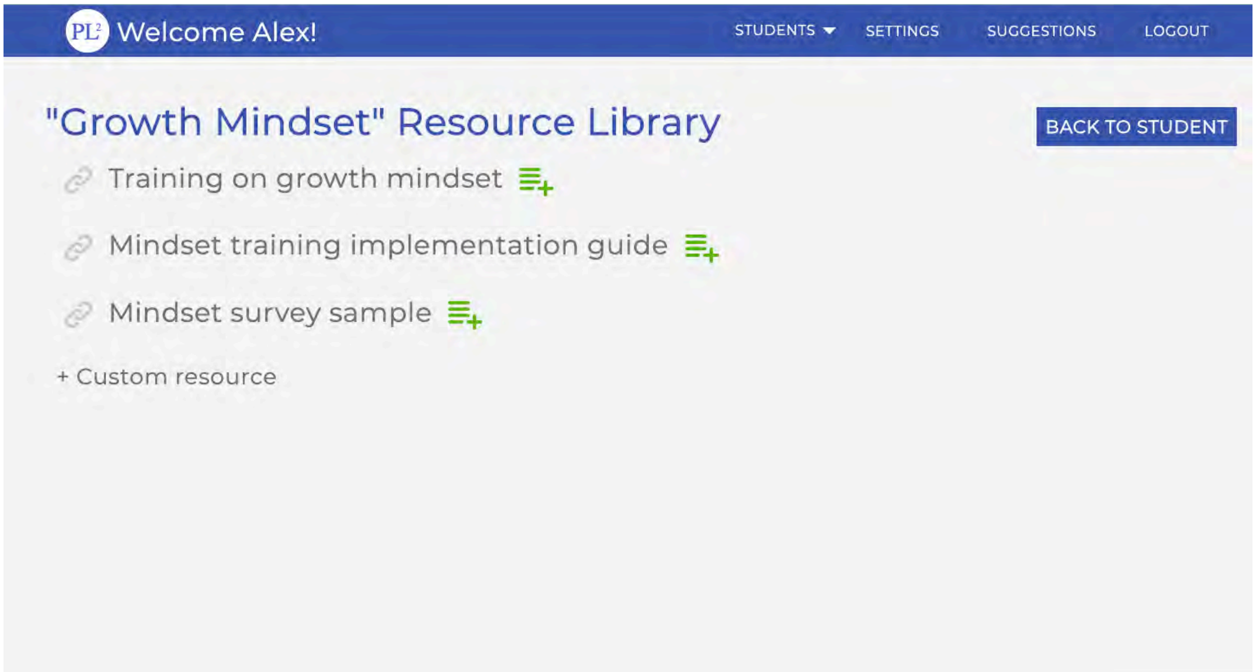

Figure 4: Example of original resource library for growth mindset category

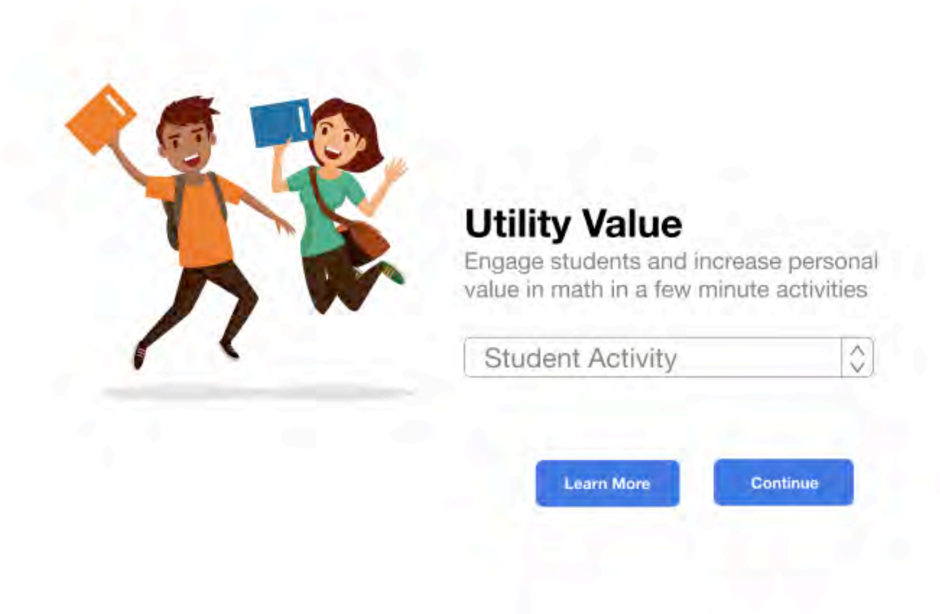

Figure 5: Example of new resource with multiple components

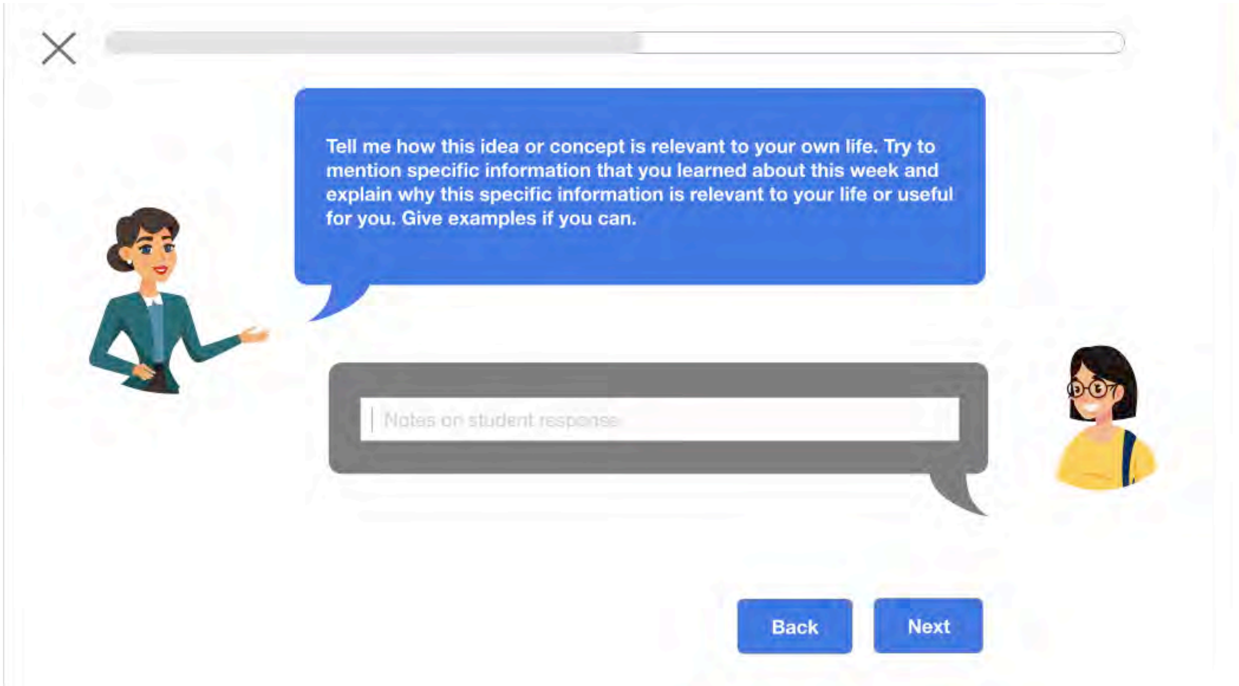

Figure 6: Example of new student activity