

# App Planner: Utilizing Generative AI for Design Thinking in K-12 Mobile App Development Education

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App Planner is an interactive Creativity Support Tool for K-12 students, designed to assist in the human-centered problem-solving and design thinking process. By utilizing generative AI chatbot features, App Planner helps students articulate the problem and solution in structured and diverse ways through guided conversations via a chat-based interface. This interface collaborates with students as a partner rather than a mentor. It assists them in brainstorming and formulating new ideas for applications, provides feedback on those ideas, and stimulates creative thinking. We mediate these conversations to follow a design thinking framework that enhances and encourages students to adopt human-centered problem-solving and critical thinking perspectives. Here we report usability tests with high-school students who appreciated App Planner for aiding the app design process and providing new viewpoints on human aspects especially the potential negative impact of their creation.

CCS Concepts: • **Human-centered computing** → **Usability testing**; **Web-based interaction**.

Additional Key Words and Phrases: Mobile Application, Generative AI, Education Technology

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## 1 INTRODUCTION & BACKGROUND

Technology wields transformative influence over society, reshaping lives at an unprecedented scale. Beyond passive consumption, we envision a world where individuals are active contributors to technological advancements. The concept of Computational Action [19, 23], a novel framework, advocates for nurturing individuals into proactive developers, capable of leveraging technology to better society and their personal lives through hands-on projects. Central to this endeavor is the development of computational thinking, a skill set defined by Jeanette Wing [27] as encompassing problem-solving, system design, and an understanding of human behavior. However, K-12 students are often new to computational thinking and programming. Students need continuous and iterative feedback, scaffolding, and support when designing and implementing open-ended projects, especially in short interventions. Furthermore, a gap exists in current STEM education, which often overlooks designing artifacts that accompany crucial elements of human behavior comprehension and the ethical implications of technology, such as its societal impact and the responsibility entailed in creating purposeful artifacts [5].

To bridge this educational gap, we propose that generative AI tools have the power to guide people to think of such a direction. These tools have the potential to provide technical, metacognitive, and reflection scaffolding [26]. Technical support can include: 1) offering continuous feedback as users work on their projects 2) Just-in-time support when users need help 3) Facilitating formative assessment. Metacognitive support, especially for promoting creativity, can include: 1) Modeling divergent thinking 2) Offering positive reinforcement during and

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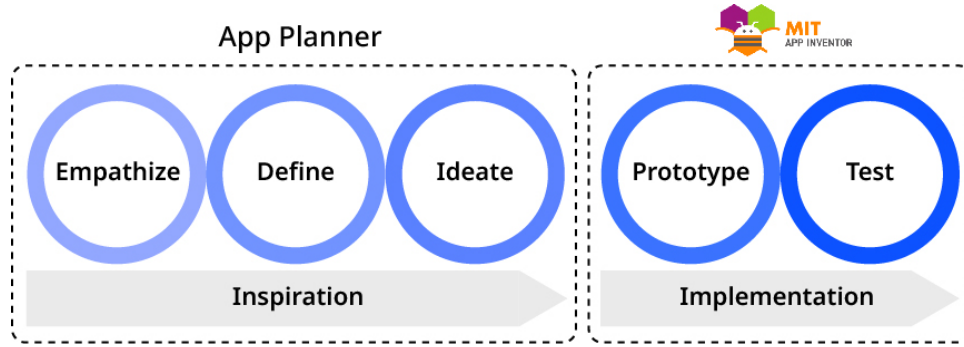


Fig. 1. Design Thinking

after project work time 3) Prompting users to engage with their creativity. Our work draws from this AI tool scaffolding framework and applies it to the context of mobile app development education.

In the realm of K-12 education, an increasing number of institutions are incorporating mobile application development into their computing curricula [6, 15, 22]. For instance, a predominant tool in this educational pursuit is the MIT App Inventor platform [21]. This platform stands out as a user-friendly visual programming environment, enabling users of all ages to craft unique applications for smartphones and tablets. In computational thinking education, researchers have built tools that automatically provide feedback to boost students' programming skills [17, 18, 25, 26]. Yet, an essential preliminary step involves assisting students in formulating and expanding on their initial ideas, as well as linking these concepts to their broader social implications.

We intend to strengthen existing app development curricula by offering the necessary support to guide users in conceptualizing new ideas and considering ethical and societal concerns within their app creation process. This paper introduces App Planner, a prototype scaffolding tool designed to guide individuals through the iterative design thinking process within app development and stimulate creative thinking. Utilizing generative AI, this tool serves as a creative companion by providing a conversational interface that facilitates the development of students' app ideas. Engaging in interactive dialogues, students are guided to clearly define their app's objectives and are provided with tailored suggestions for functionalities and designs that align with their envisioned goals. App Planner functions not just as a tool but as an educational collaborator, aiding in brainstorming sessions and imparting critical concepts in problem-solving and design thinking.

### 1.1 Design Thinking

Design Thinking is a user-centered problem-solving method defined by T. Brown [3]. Brown suggests that design thinking consists of inspiration, ideation, and implementation. Design thinking has the potential to craft impactful solutions for social challenges, yet its success hinges on thorough adoption and usage. T. Brown provides an example of Naandi Foundation setting up a safe water center in rural India. However, due to impracticalities like the mandatory use of heavy 5-gallon containers, locals still prefer water from a nearby borehole. This situation underscores a critical lapse in design thinking at the center, reflecting a failure to fully account for the community's varied needs and cultural practices. Effective design thinking goes beyond mere problem-solving; it necessitates a proactive approach in problem identification and understanding user contexts for meaningful social innovation.

## 1.2 Generative AI-based Large Language models

Generative AI-based large language models are sophisticated artificial intelligence systems designed to understand, interpret, and generate human-like text [1]. These models, built on extensive neural network architectures, are trained on vast datasets of human language from diverse sources, enabling them to grasp and mimic a wide range of linguistic styles and nuances. Their generative capabilities allow them to produce coherent, contextually relevant text, making them adept at tasks like translation, education, question answering, and conversational agents [9, 14]. The underlying technology of these models involves complex algorithms that process and predict language patterns, often utilizing deep learning techniques such as transformers [24]. These algorithms enable the models to generate text that is not just syntactically correct but also semantically rich and contextually appropriate. As a result, generative AI language models can engage in human-like dialogue, provide insightful responses, and even create content that resonates with human readers.

## 1.3 AI Tools for K12 Learning

Previous research has demonstrated the effectiveness of AI tutors and robotic mediators in enhancing student learning [16]. Additionally, learning agents have been instrumental in fostering creativity and self-efficacy among students [2, 7, 20]. The role of these agents in facilitating reflective practices has been shown to improve students' creative processes and their application of conceptual knowledge [10, 11]. Automatic scaffolding tools can provide technical, metacognitive, and reflective scaffolding for students and educators as they learn [26]. Similar research has leveraged intelligent tutors to help students engage in computational thinking and improve their programming. Our tool leverages generative AI to empower students to brainstorm novel and creative ideas for their mobile applications and encourages them to refine their designs by considering the ethical implications associated with such a tool.

## 2 TOOL OVERVIEW

App Planner (Figure 2) facilitates each phase of app development for students. The process starts with a text box prompting students to enter the title of their project or the desired name for their mobile application. The next steps are based on the key features of 'Design Thinking' (Figure 1). The organization of the sections and questions scaffold users through the design thinking and brainstorming process.

**Define:** The next text box invites students to articulate the problem they aim to address by describing the type of app they envision creating to tackle this issue. Students are encouraged to analyze the problem they want to solve, identify target users, and consider specific contexts in which the problem occurs. This systematic approach promotes a human-centric perspective, prompting students to think critically before delving into feature development. If they find themselves at a deadlock or struggling to progress, they have the option to engage with an intelligent chatbot. The chatbot's role is to offer a blend of rule-based instructions for systematic guidance and AI-powered suggestions for creative enhancement. Students are provided with interactive options such as buttons labeled 'How can I define a problem?', 'Who are the target users?', and 'When and where do users encounter this problem?'. Clicking these prompts them with examples and insights to foster a deeper understanding of these aspects. Additionally, students can directly input queries like *"I want to help my mother with her English; what kind of app should I make?"* Such inquiries are processed through our backend, where we utilize OpenAI's API to send these requests to the GPT model. GPT's advanced capabilities then generate tailored responses, offering students creative and practical suggestions for their app development queries. This conversation is the cornerstone of our tool, assisting students in refining their ideas into solid goals and objectives.

**Design:** Following this, App Planner offers a dedicated section for discussing the application design. Here, students can deliberate on the user interface and app functionality, considering how to best structure their app to achieve the defined goals. For instance, a student might want to add a translator component to help their

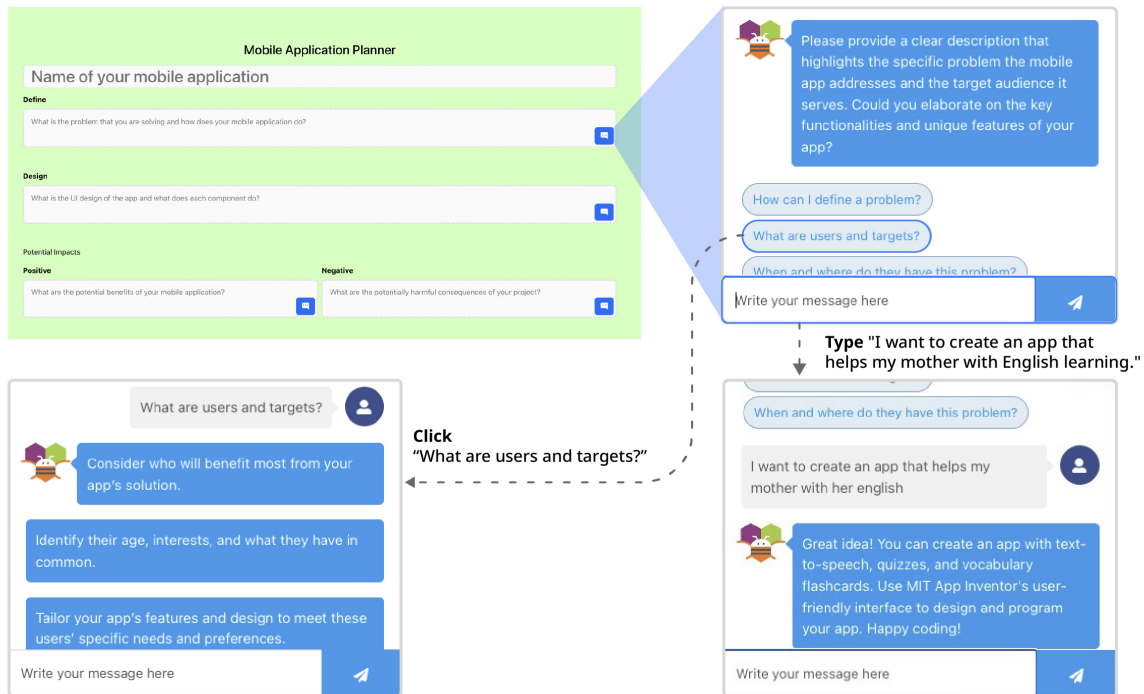


Fig. 2. The tool is structured around five key text boxes, each guiding the user through a distinct stage of app development. If students encounter difficulties while filling out any of the text boxes, they have the option to consult with a chatbot, as illustrated in the top right image. For immediate guidance, they can select one of the pre-set question bubbles to receive a rule-based response like the bottom left. Alternatively, like the bottom right students can directly input their queries, which will be processed through an API call to ChatGPT, providing them with tailored assistance and clarifications, enhancing their understanding and progress.

mother learn English. This will require the student to add a text box and a button, where the mother can type in their language and press the button to see the English-translated version. To further the design process, the Planner provides guided prompts and examples, ensuring that students' exploration remains in line with their vision. Students can ask what features should be added and how to integrate such features into their app design to make it user-friendly. This phase also encompasses the 'Ideate' and 'Prototype' stages in the Design Thinking framework.

**Positive and Negative Impact:** In the final stage, students are encouraged to thoroughly consider both the positive and potential negative impacts of their applications. For this critical thinking exercise the interactive chatbot serves as a brainstorming partner to explore various perspectives and consequences [4]. This step ensures that the students' creations are not only goal-oriented but also ethically sound and socially responsible. The inclusion of the chatbot enriches the learning experience, making it both engaging and educational. It underscores the cultivation of a well-rounded skill set that includes app design, ethical reasoning, and critical thinking – essential attributes for the responsible creators of tomorrow.

Table 1. Paritipants

Participant	Age	Prior coding experience	Experience in building apps
P1	17	Very little	None
P2	17	A lot	A lot
P3	17	Very little	None
P4	18	Some	Some
P5	17	None	None

### 3 PILOT TEST

#### 3.1 Participants

Our pilot study was conducted with a cohort of five high school students (Table 1), all in their senior year, representing a diverse range of experiences and backgrounds in mobile application design and development. This varied participant group was strategically chosen to provide insights into how students with different levels of expertise and familiarity with app creation respond to the use of our tool. The diversity in their backgrounds was intended to enrich the data and offer a more comprehensive understanding of the tool’s applicability and effectiveness across a spectrum of user experiences. This study was conducted as part of a university class project and adhered to a rigorous Institutional Review Board (IRB) process. The IRB approval was obtained from the anonymous university, ensuring that all research methods, participant recruitment, and data handling procedures complied with ethical standards and regulatory guidelines.

#### 3.2 Methodology

In our pilot study, we implemented a structured approach to evaluate the effectiveness of the App Planner tool. The participant pool underwent a preliminary survey to gauge their confidence in programming skills and familiarity with generative AI technologies. Following this, they were assigned two distinct design tasks. The first task required participants to conceptualize an app aiding students in day planning, with an emphasis on features like monitoring lunch menu trends to inform their meal choices. The second task focused on career exploration, asking participants to design an app that assists students in identifying potential career interests and connecting them with relevant community resources or professionals. For each task we asked the participants to draw and describe the app they designed.

Participants were instructed to create a detailed textual description of their envisioned app for each task. To assess the impact of our App Planner tool, we varied its usage among participants. For participants P1, P2, and P3, the first task was completed without the aid of the App Planner, and they utilized the tool for the second task. Conversely, participants P4 and P5 were provided with the App Planner for the first task and completed the second task independently. This methodology was designed to juxtapose the app design process with and without the assistance of the App Planner, thereby allowing us to analyze its efficacy in enhancing the participants’ design experience and outcomes. The study’s objective was to gain insights into how the tool influences the app development process, particularly in terms of creative ideation, problem-solving, and the overall usability of the tool in a real-world scenario.

Upon the completion of the two design tasks, we conducted semi-structured interviews with each participant. These interviews provided a platform for in-depth exploration of their experiences, allowing us to delve deeper into their thought processes, challenges encountered, and the perceived benefits or drawbacks of using the App Planner tool. The whole process took around 90 minutes for each participant.

Table 2. Example of App Descriptions

Without using App Planner	With using App Planner
Create a game where you track breakfast, lunch and dinner and everytime you eat something healthy you win one point	Make an app with a text box and a button that says "save". After click the button, create a list with all the text that was written in the text box. On a second page, use Chatbot to ask for stress management tips. Using Chatbot classify the elements of the list in three groups: academic, social and professional.

### 3.3 Observation

Every participant actively uses App Planner, but the user experience they have while interacting with App Planner has both commonalities and differences among individuals. Overall, the stage that users prefer the most for **frequent use of the 'AI chat feature' is the 'Design' and 'Negative Impact'** of the app. They use the chat feature to ask for design ideas such as "How can I make a list?" (P3), inquire about the types of resources that would help kids (P1), or seek potential output of the solution like "What would be an example of a privacy concern for this app?" (P4). They ask follow-up questions to the AI chat if the initial result from AI is obscure or too broad, such as "What is a career exploration quiz?" (P5). Some participants actively use App Planner not only in the 'Planning' stage but also voluntarily use chat features again in the stage of drawing the app flow and screens. They check what they have written in the box and chat history, or even re-ask follow-up questions in the 'Design' field to gather more detailed information. P5 even adds a design section after drawing the app to explain the features in a more detailed way (menu), aiming to solidify ideas while incorporating them into the drawn box. The timing for using the AI chat feature differs among individuals. Some participants prefer to fill out the blank by themselves initially and use the chat feature later, while others prefer to use the chat feature together at the beginning of filling out the blank. When we asked the participant (P5) who used the chat feature later in the semi-structured interview, she mentioned that she didn't want to rely too much on AI, stating, "Our opinions should be valued more when we decide what and why we need for the app, and AI can help with more technical aspects."

### 3.4 Preliminary Results & Discussion

Table 2 illustrates the notable enhancement in the quality of app descriptions with the use of the App Planner. In the absence of the App Planner, participants were observed to provide relatively basic descriptions, often defining only a singular feature, such as 'Create a game'. Conversely, when utilizing the App Planner, the participants offered more detailed and comprehensive descriptions. They not only outlined the app's features but also delved into the specifics of the user interface elements like text boxes, buttons, lists, and chatbots. Moreover, they described the functionalities and actions associated with these elements, such as the events triggered by button clicks and the process of requesting and classifying elements. This comparison underscores the App Planner's effectiveness in aiding users to articulate richer and more intricate app concepts.

The semi-structured interview from our pilot study also revealed many interesting viewpoints from the participants. The feedback from participants highlighted a strong preference for working with the App Planner as opposed to navigating the app design process independently for the following reasons.

- **Easier to Proceed:** Participants found that the App Planner facilitated a more streamlined and efficient design process. One participant noted, "With App Planner, I could think more, and it was faster to make (P1)," emphasizing the tool's ability to expedite the design phase. Others mentioned how the App Planner provided

crucial guidance when they felt stuck, helping them to articulate their ideas more clearly. The overall agreement among participants was that, in the absence of the App Planner, the planning of subsequent steps in the app development process posed more challenges. As stated in the study (P1), “The App Planner was more specific, making it much easier to follow the instructions.”

- **Practical Tips:** The participants also appreciated the practical advice offered by the App Planner. P2 highlighted the value of learning specific design elements like creating a list view, which, while searchable on Google, was more conveniently accessible and contextual within the App Planner. Another participant praised the creativity and helpfulness of the advice offered by the chat feature, finding it not only useful but also engaging. “With App Planner, I think the chat feature helped find specific technical information.” (P5)
- **Expanding Thoughts:** The App Planner was also recognized for its role in broadening the participants’ perspectives. As they described their ideas, the tool helped them to expand upon these concepts, offering new dimensions and depth to their initial thoughts. This aspect of the App Planner was crucial in enhancing the creativity and scope of the participants’ app designs.

Based on responses, App Planner played a significant role in cultivating a human-centered mindset among students. Especially regarding the societal impact and user-centric design of their apps.

- **Thinking about Users:** The App Planner also influenced how students thought about the users of their apps. Without the tool, some students found themselves focused solely on their personal needs and perspectives. “When I made the app by myself, I realized that considering diverse situations wasn’t as comprehensive as when I used App Planner.” (P5). However, the App Planner encouraged them to consider a wider range of users. One student observed, “When using the App Planner, I could think about more general users,” indicating a shift from a self-centric to a user-centric approach in app design.
- **Impact on Society:** All students expressed that considering the positive and negative impacts of their apps was a novel concept for them. “I typically focus on the benefits, so asking me about the negative impacts was helpful” (P1), “Thinking about the positive/negative impact of the app was new to me.” (P5). This reflects a shift in their thought process, prompted by the App Planner, to include broader social considerations in their design. Another student noted the uniqueness of receiving advice related to social issues and user needs, which was not typically emphasized in their computer science classes. “Negative & Positive outcome was extremely helpful, I didn’t learn that a lot” (P3) The feature of evaluating both negative and positive outcomes was highlighted as particularly beneficial, all students mentioned that using app planner “broadened perspectives.”

Finally, we also asked the participants their preference of partner in the app creation process, friends, teachers, parents, or AI. Students displayed a clear preference for collaborating with friends during the app creation process. They valued the shared perspectives, enjoyment, and creativity that comes with working in a group. There is also an opinion that friends can offer creative ideas, whereas AI might provide more common suggestions, which was also a recurring theme. “Friend can come up with creative ideas, but AI will give you common ideas.” (P2) The enjoyment of working with peers was highlighted as irreplaceable by AI. However, the App Planner was seen as a valuable tool, especially adding some professional advice. One participant mentioned, “AI can provide me with more professional ideas. After establishing our own idea, we can incorporate additional insights from AI.” (P5)

This suggests a desire to blend the creative and social dynamics of group work with the structured guidance provided by the App Planner. One student stated, “I prefer friends, but if they are not professional, I hope to use the App planner together” (P2) reflecting the perceived value of the tool in supplementing the group’s expertise.

#### 4 CONCLUSION

Our paper presents the App Planner, a pioneering tool designed to enrich computer science curricula by infusing ethical considerations into app development. The study underscores AI’s potential as a dynamic support



mechanism in teaching human-centered problem-solving, highlighting how generative AI can strengthen education by fostering proactive problem-solving skills, autonomy, and humanity-focused considerations. The App Planner, leveraging generative AI, serves as a practical design aid and as an educational platform that enhances problem-solving, critical thinking, and creativity. Feedback from our pilot study reveals a strong preference among students for the App Planner over working independently, as it streamlines design, provides practical advice, and encourages expansive thinking. It promotes a human-centered approach, urging students to consider the societal impact of their creations. The tool’s integration into collaborative work further suggests its potential in blending structured guidance with the social dynamics of group creativity, enhancing both the learning experience and the quality of app designs.

## 5 FUTURE DIRECTIONS

In our future endeavors, we aim to strategically align our platform with established educational technology platforms, notably the MIT App Inventor. Such an integration will not only expand our reach but also enhance our user testing capabilities, leveraging the extensive user base of these platforms. A key focus of this integration will be collaborating with the ongoing development of ‘Aptly’ by the MIT App Inventor team [8, 13], a cutting-edge platform designed to enable app creation through natural language inputs. Recognizing the challenges younger users may face in articulating app functionalities verbally [12], our App Planner is positioned to play a crucial role. It will act as an intermediary tool, easing these communication challenges and facilitating a more streamlined design process within Aptly. This collaborative approach aims to merge intuitive language-based app creation with the structured, guided experience that the App Planner provides, thus fostering a more inclusive and effective learning environment in app development education.

## ACKNOWLEDGMENTS

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