Building an iOS App to Support Researchers and Teachers in Identifying Scientific and Engineering Practices in Preschoolers' Play

Rose Xi, Class of 2022

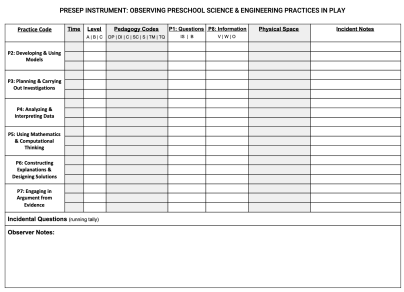
Background Miller and Saenz have conducted research over the past two years and developed "SciEPOP" – an instrument to help researchers and teachers identify and support children's engagement with STEM learning when they interact freely with their environment during self-directed "free-play". Throughout the summer, I have transformed this instrument into a digital form by designing and developing an iPad based app-version of SciEPOP that provides an intuitive and user-friendly interface, more convenience than the traditionally paper-based observation protocol, as well as more flexibility to be used for various research purposes. The app can be used on all iPad devices with an iOS version of 14.1 or above, and it will be deployed onto the Apple App Store and made available for other researchers who are eager to use the instrument in their own work and research.

Methods To design the app, I first conducted needfinding interviews with users of the SciEPOP instrument in order to discover their latent needs and get a better understanding of the observation workflow. After identifying the main goals and problems that the app should address, I created a wireframe for the app, which is an outline that provides an overview of the app structure, layout, functionality, and user flow. Based on the wireframe, I then used Figma to create a rapid prototype containing more styling, color, and detailed designs. The prototype was used to test and get early feedback from the users, and the feedback received guided me to make improvements and refine the design. After going through four iterative stages of the design process to finalize the user interface, I proceeded to implement the design and functionalities on an iOS system. The application was developed in the XCode environment using SwiftUI, and tested on all iPad devices.

Results The application has 12 main features and functionalities: **1) Manage study** – users can add observation sites and observers associated with the study. **2) Add new observation sessions** – users can enter the site and observer for the session, the date of observation, notes, and the color (which can be used to separate sessions into categories as defined by the user). **3) Archive/Unarchive sessions** – sessions can be moved between Current Observations and Archived Observation to help users keep their focus on specific sessions of ongoing study while allowing them to keep records of past observations. **4) Edit or Delete sessions**. **5) Add new incidents in a session** – when the user clicks into a session, a list of incidents will be displayed. For each incident, the user can a) Add to favorites, b) Edit incident name, c) Record the start and end time, d) Select multiple Practice Codes and Pedagogy Codes, e) Tally number of questions asked in each question type, f) Log notes about the physical space or incident, and g) Save the incident. **6) View Protocol Info** – Users can click on info buttons next to acronyms and codes to get detailed explanations of what they stand for in the protocol. **7) Edit or Delete incidents in a session**. **8) Filter incidents based on Favorite status. 9) Archive/Unarchive or Delete multiple sessions. 10) Download and Share data from selected sessions –** all the information recorded for the session and each incident in the session will be exported to a csv format and made available to be shared with other devices or individuals via email, messaging apps, text, etc. **11) Persistent Data Storage** – Data entered in the app will be saved locally on the device and will not disappear when the app is terminated. **12) Responsive Layout –** The app layout is adaptable and will automatically resize to display information as intended on all screen sizes of iPad devices.

Figures

Paper Protocol



PRESEP INSTRUMENT: OBSERVING PRESCHOOL SCIENCE & ENGINEERING PRACTICES IN PLAY

Practice Code	Time	Level A | B | C	Pedagogy Codes DP | DI | C | SC | S | TM | TQ	P1: Questions SI | B	P2: Information V | W | O	Physical Space	Incident Notes
P2: Developing & Using Models							
P3: Planning & Carrying Out Investigations							
P4: Analyzing & Interpreting Data							
P5: Using Mathematics & Computational Thinking							
P6: Constructing Explanations & Designing Solutions							
P7: Engaging in Argument from Evidence							
Incidental Questions (running tally)							
Observer Notes:							

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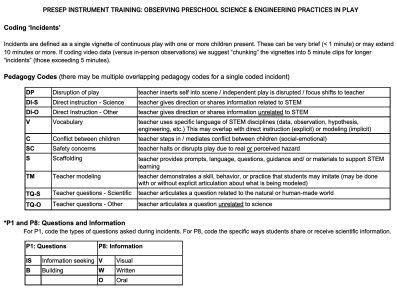


PRESEP INSTRUMENT TRAINING: OBSERVING PRESCHOOL SCIENCE & ENGINEERING PRACTICES IN PLAY

Coding 'Incidents'

Incidents are defined as a single vignette of continuous play with one or more children present. These can be very brief (< 1 minute) or may extend 10 minutes or more. If coding video data (versus in-person observations) we suggest "chunking" the vignettes into 5 minute clips for longer "incidents" (those exceeding 5 minutes).

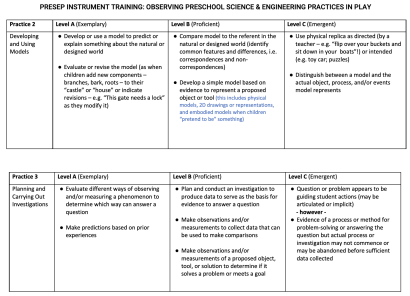
Pedagogy Codes (there may be multiple overlapping pedagogy codes for a single coded incident)

DP	Disruption of play	teacher inserts self into scene / independent play is disrupted / focus shifts to teacher
DI-S	Direct Instruction - Science	teacher gives direction or shares information related to STEM
DI-O	Direct Instruction - Other	teacher gives direction or shares information unrelated to STEM
V	Vocabulary	teacher uses specific language of STEM disciplines (data, observation, hypothesis, engineering, etc.) This may overlap with direct instruction (explicit) or modeling (implicit)
C	Conflict between children	teacher steps in / mediates conflict between children (social-emotional)
SC	Safety concerns	teacher halts or disrupts play due to real or perceived hazard
S	Scaffolding	teacher provides prompts, language, questions, guidance and/ or materials to support STEM learning
TM	Teacher modeling	teacher demonstrates a skill, behavior, or practice that students may imitate (may be done with or without explicit articulation about what is being modeled)
TQ-S	Teacher questions - Scientific	teacher articulates a question related to the natural or human-made world
TQ-O	Teacher questions - Other	teacher articulates a question unrelated to science

***P1 and P8: Questions and Information**

For P1, code the types of questions asked during incidents. For P8, code the specific ways students share or receive scientific information.

P1: Questions		P8: Information	
SI	Information seeking	V	Visual
B	Building	W	Written
		O	Oral

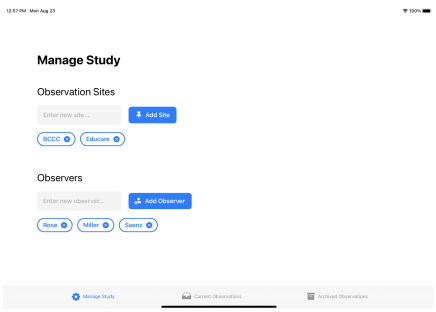


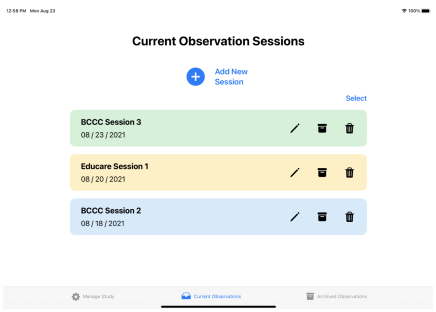
PRESEP INSTRUMENT TRAINING: OBSERVING PRESCHOOL SCIENCE & ENGINEERING PRACTICES IN PLAY

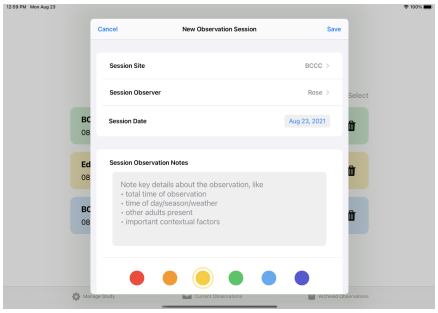
Practice 2	Level A (Exemplary)	Level B (Proficient)	Level C (Emergent)
Developing and Using Models	• Develop or use a model to predict or explain something about the natural or designed world • Evaluate or revise the model (as when children add new components – branches, bark, roots – to their "castle" or "house" or indicate revisions – e.g. "This gate needs a lock" as they modify it)	• Compare model to the referent in the natural or designed world (identify common features and differences, i.e. correspondences and non-correspondences) • Develop a simple model based on evidence to represent a proposed object or tool (this includes physical models, 2D drawings or representations, and embodied models when children "pretend to be" something)	• Use physical replica as directed (by a teacher – e.g. "flip over your buckets and sit down in your boats!") or intended (e.g. toy car, puzzles) • Distinguish between a model and the actual object, process, and/or events model represents

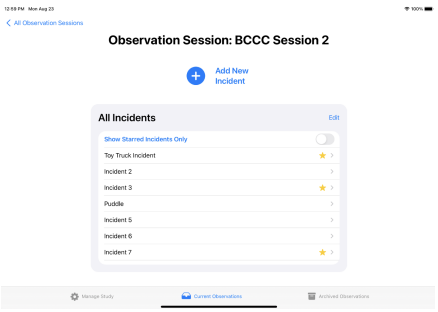
Practice 3	Level A (Exemplary)	Level B (Proficient)	Level C (Emergent)
Planning and Carrying Out Investigations	• Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question • Make predictions based on prior experiences	• Plan and conduct an investigation to produce data to serve as the basis for evidence to answer a question • Make observations and/or measurements to collect data that can be used to make comparisons • Make observations and/or measurements of a proposed object, tool, or solution to determine if it solves a problem or meets a goal	• Question or problem appears to be guiding student actions (may be articulated or implicit) **- however -** • Evidence of a process or method for problem-solving or answering the question but actual process or investigation may not commence or may be abandoned before sufficient data collected

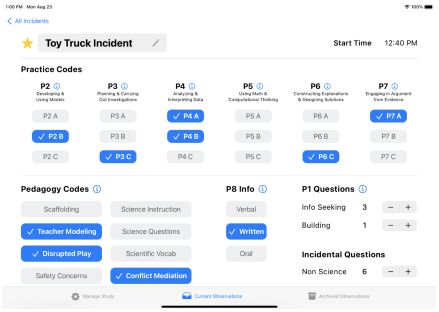
Application Screenshots

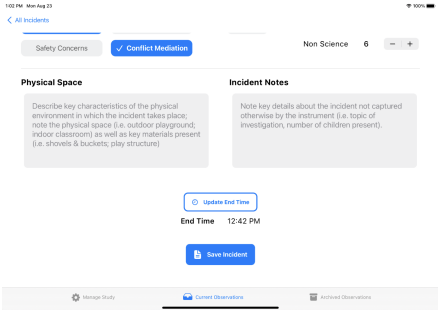


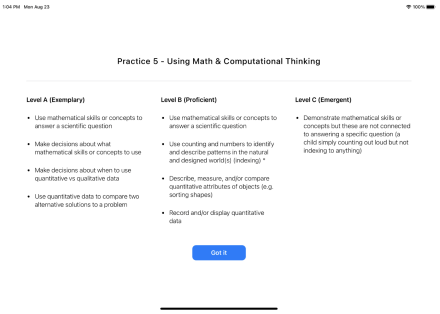


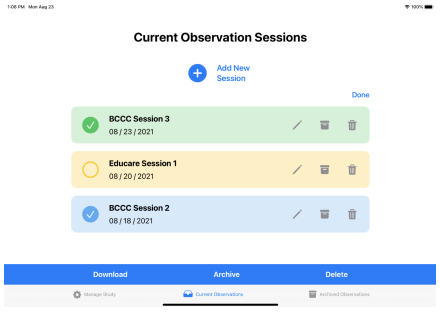


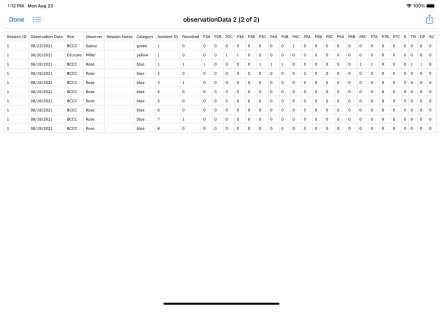












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