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[Work in Progress] Iterative development of an IT solution supporting Early Learning Standards

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[Work in Progress] Iterative development of an IT solution supporting Early Learning Standards

Abstract

This work-in-progress paper details the efforts of a small team of undergraduate students majoring in Computer Science as they provide technological assistance to a non-profit community partner whose mission is to continually improve the quality of education provided to children from birth through pre-kindergarten. Our community partner is The Children's Center (TCC), a non-profit provider of early childhood education and childcare services located in an affluent region of South Carolina. TCC's purpose is to deliver quality early education and childcare services to the working family, providing services on a sliding tuition scale based on parental income. TCC's non-profit status presents a limited budget for information technology, and therefore certain processes that could otherwise be automated by expensive IT solutions must still be performed manually.

One such process is the generation of student progress reports, which follow the South Carolina Early Learning Standards (SC-ELS). These are state-imposed goals and developmental indicators used by early learning organizations to measure student growth. The SC-ELS indicators differ depending on the age periods of the children, from infants to older preschoolers. Further challenge is posed by language, as the diverse population served by TCC is approximately 50% English as a Second Language (ESL). Consequently, different report card formats are needed for each age group attending TCC, in both English and Spanish languages.

In response to this challenge, we developed, at no cost, a semi-automatic software tool that facilitates the process of generating report cards whose formats must be tailored to the different age groups and preferred languages served by TCC. The tool not only helps to expedite the generation of the report cards themselves, but it also enables the user to generate aggregate statistics about student performance. That is, it enables the user to analyze and interpret the data easier than the previous manual approaches that were time-consuming, error-prone and impractical.

Despite the current progress made, several sub-processes are still manually completed. Our ongoing efforts involve continual improvement of the tool through further process automation.

Background

The South Carolina Early Learning Standards (SC-ELS) are guidelines curated by the state to help establish an answer to the question "What foundational skills do children need to experience success in school?" [3]. The SC-ELS guidelines are divided into 6 different indicators, which are then categorized depending on the age-group being observed, ranging from birth to kindergarten entry age (5 years) [3]. The intention of setting foundational guidelines is to allow family members, educators, administrators, and policy makers to best prepare their children for success when they enter school [3].

When assessing a large student body across numerous categories with multiple tracking mechanisms, the creation of progress reports becomes cumbersome when done manually. The regular frequency at which progress reports were generated for each student, with summarization reports generated for each classroom, repetition makes this subprocess an ideal candidate for automation. An example of such a tool would be PowerSchool, described as a "student information system-software solution for K-12 educational institutions". Such tools facilitate the primarily automated generation of student progress reports. These tools greatly reduce the time and manual effort required

Using IT solutions like PowerSchool is an effective use of time and money. However, when running with a non-profit model, organizations who have a restricted budget cannot afford these opportunity costs. This is the situation The Children's Center finds themselves in. The Children's Center (TCC) is a non-profit early learning center located in Hilton Head Island, South Carolina. With a student count of over 100, TCC finds themselves in a situation that using such a tool can be an effective supplement to their organization's operation. Yet, with their restricted resources stemming from their business model, such a tool cannot be adopted. With the adoption of the SC-ELS guidelines, TCC employ a largely manual process of progress report generation with several points of failure.

With this predicament in mind, a small team at the University of South Carolina-Beaufort have taken the opportunity to work together with TCC to address the need for a better solution.

Currently, the project has addressed the ability to generate progress reports dynamically by using Microsoft SQL Server, creating progress reports depending on the child's attributes allowing for the ability to interpret and present statistics using a database of relevant information. Despite the original manual practice being improved, the project is now moving towards addressing another aspect of the process. Namely, creating a user-interface application that will contain all the functions necessary to create progress reports. This is where the project currently stands.

South Carolina Early Learning Standards

The South Carolina Early Learning Standards (SC-ELS) are goals and developmental indicators of what children are expected to understand from age birth to kindergarten-entry (5 years of age). These standards are divided into 6 indicators [2] as depicted in Figure 1. Each of the indicators is integral to the SC-ELS model, as children do not develop equally. These indicators overlap as growth in one area can correlate to growth in another. Take for example the progress a child makes

when interacting with adults (Social Development), they then learn new words (Language Development) that help them understand new concepts (Cognitive Development) [2]. This understanding is important for both teachers and caregivers who utilize the SC-ELS model to use the system most effectively. It is imperative to understand that although these are metrics used to gauge a child's development, they are not "required" goals. These are simply means to measure a child's growth as opposed to "grading" a child.

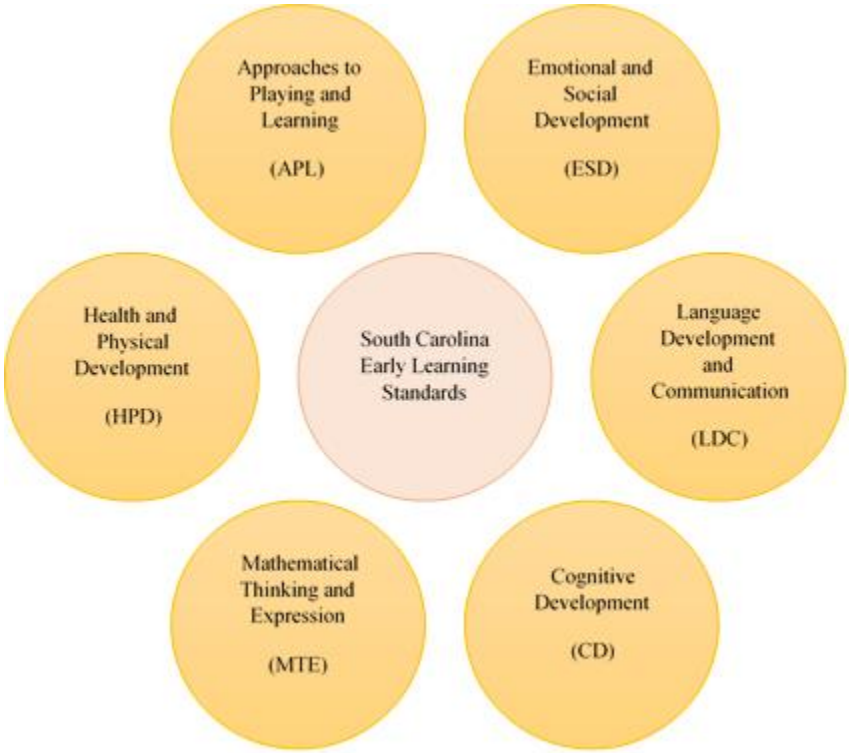

Figure 1: The six indicators of SC-ELS

The Children's Center

The Children's Center (TCC) is a non-profit early learning organization located in Hilton Head Island, South Carolina [1]. TCC provides families of lower economic standing an opportunity to enroll their children into an affordable multicultural and bilingual educational program. TCC utilizes a tuition sliding scale that is based on the parental income, allowing for wider accessibility. The student body that TCC serves are aged birth to pre-kindergarten entry (five years of age), stemming from a variety of cultural backgrounds. Adopting the South Carolina Early Learning Standards, TCC focuses on developing a child's social-emotional growth, gross and fine motor skills, language and literacy, mathematics, and cognitive development [1].

Problem

When viewed as a multi-step process, all steps in the assessment, evaluation, and dissemination of student progress were manual and non-electronic. Consequently, this multi-step process was cumbersome, time consuming, and extremely vulnerable to human error. Additionally, data analysis capabilities were extremely limited.

Prior to the creation of the partnership between TCC and members of the University of South Carolina-Beaufort, the progress report generation infrastructure had been developing over time. Before the adoption of the SC-ELS, TCC had initially no such system for tracking and reporting a child's growth other than observations made by teachers. With TCC adopting the SC-ELS guidelines in 2017, this would mark the beginning of their progress reporting framework. Below are bulleted points describing the initial process set in place by administration.

- Following the adoption of SC-ELS guidelines, administration created a formatted Microsoft Excel Spreadsheet containing all of the developmental indicators with their corresponding descriptions per age group. An example is provided in Figure 2.
- For each child, create a folder and print the formatted spreadsheet to begin tracking their growth.
- When a child is observed by a teacher to have completed a certain task, the teacher will then write down the date of the occurrence and sign off with their initials.
- At the end of the day, reports are then collected by administration by hand, visiting each classroom personally.
- The folders containing the reports are then collected and stored.

Early Learning Standards Student Assessment - The Children's Center

Infants (Birth to 12 months) -

Approaches to Learning and Play (APL)

Child:		Date mastered by child	Teachers Initials
Goal APL-1: Children show curiosity and express interest in the world around them.		Date	Initials
APL-1a	Show interest in others (smile or gaze at cargiver, make sounds or move body when other person is near.		
APL-1b	Show interest in themselves (watch own hands, play with own feet.		
APL-1c	Reach to new sights, sound, smell, taste and touches (stick out tongue at first solid food, turn head quickly when door slams)		
Goal APL-2: Children actively seek to understand the world around them.		Date	Initials
APL-2a	Explore the indoor and outdoor environment using all available sences - smell, hear, see, feel and taste.		
APL-2b	With appropriate supports, move toward interesting people, sounds, objects and activities.		
Goal APL-3: Children Engage in increasingly complex play.		Date	Initials
APL-3a	Show interest in other children playing (watch, turn toward).		
APL-3b	Imitate sounds, facial expressions, or gestures (cover face with hands, hands up for "so big").		
APL-3c	Play with simple objects, using them to make sounds and other interesteing results.		
APL-3d	Begin to participate in gave-and-take exchanges of sounds and gestures ("serve and return").		

Figure 2: Manual Data Collection and Management (hardcopy)

Using this largely manual procedure, the first iteration of tracking and creating reports has been established. However, administration had noted several factors complicating setting up and performing the process. When initially setting up the spreadsheet containing the descriptions where progress would be documented, the guidelines were very numerous. An example is provided in Figure 3. Approaches to Playing and Learning (APL) had a set number of goals of up to 15 per age group. Each of these goals had one or more sub-categories. APL-1 for infants had 3 sub-categories, APL-2 had 2 sub-categories, APL-3 had 4 sub-categories and so on.

The running total of sub-categories TCC adopted for APL totaled 140 across all age-groups. For APL alone, this would mean a total of up to 140 observations being made per child assuming full attendance from birth to kindergarten-entry. Ultimately, this style of documentation would result in large amounts of information being physically stored in the form of having hardcopy printouts of spreadsheets containing handwritten marks in folders for each child. Consequently, any meaningful effort to analyze the data on a macro scale is impractical. Data analysis could only be meaningfully practiced for one child at a time.

The current tracking metrics used in progress reports are hard to interpret and unreliable. This fact is not helped by the number of goals being so vast. A point of contention in the system was the method in how progress was being tracked. Namely, the subjective nature of tracking

progress by observation, along with the binary results of either failing to complete the category or fulfilling the requirements. Using this system meant that one could not easily tell if progress was being made. Additionally, what one individual may consider completion of a certain task may not be what another individual deems completed.

Given the challenges of the largely manual process used by TCC for assessment of their students, we propose herein an updated assessment process that introduces greater automation of data collection and storage. Our proposed process is described in the next section.

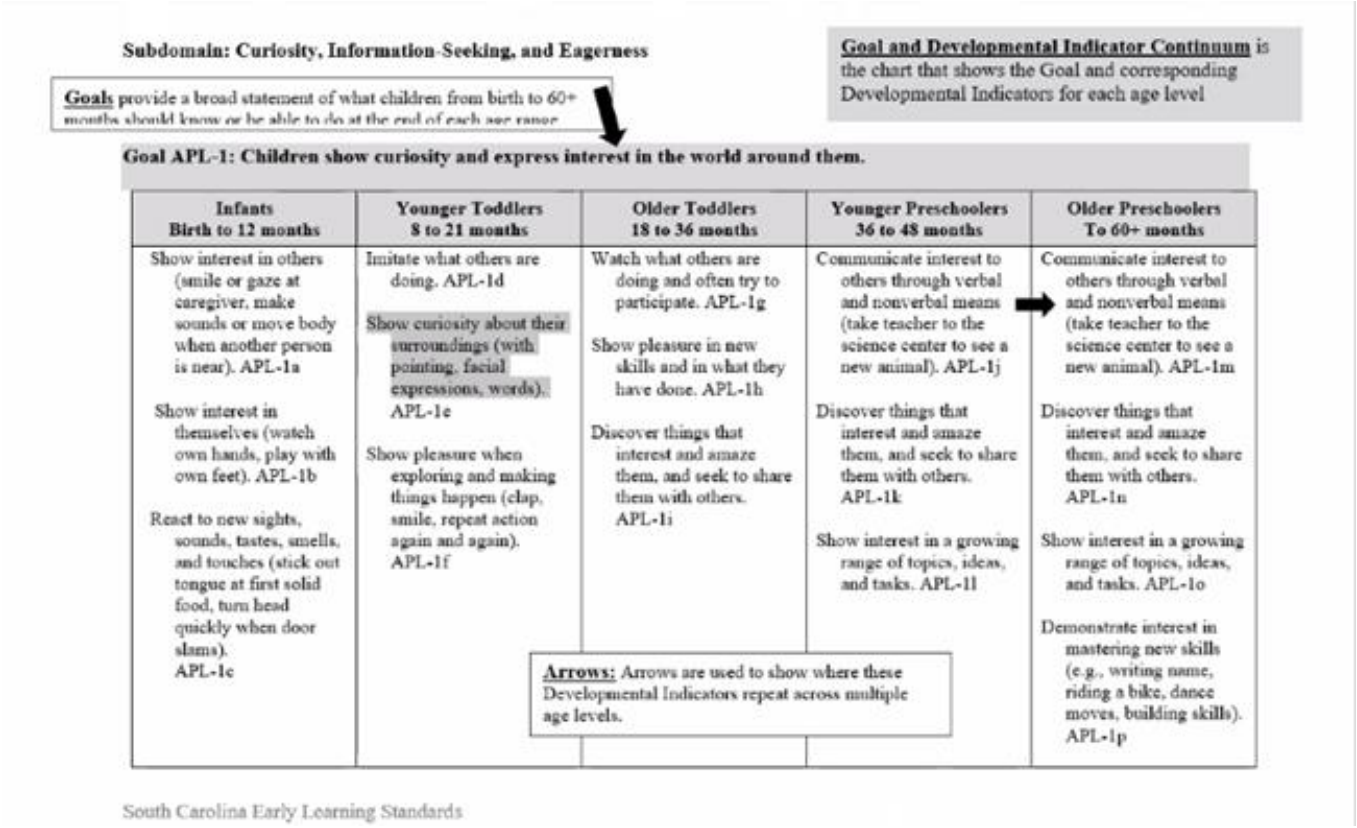

Figure 3: South Carolina Early Learning Standards (SC-ELS) APL-1

Solution

In response to the problems identified above and embracing the perspective that TCC employs a multi-step process in assessment, evaluation, and dissemination of student progress, our team has sought to incrementally design and implement a software application to facilitate the process. This application facilitates data collection, storage, and retrieval. Particular priority has been placed upon automating steps within the process that readily allow it.

Modeling prior effort as the first iteration of a software design process

In order to highlight the correspondence between the prior, largely manual procedure that TCC had been following, our suggested improvements to introduce more automation and efficiency, it seemed prudent to model each of these "before-and-after" approaches as an iteration of a software development lifecycle (SDLC). Of the SDLCs that we researched, we observed that the Information Technology Infrastructure Library (ITIL) software cycle model [7] most closely approximated the process by which TCC was performing their assessment data collection, storage, and analysis while also being compatible with our proposed improvements to that process. ITIL can be described as "a set of concepts and policies for managing Information Technology (IT) infrastructure, development , and operations. [10]"

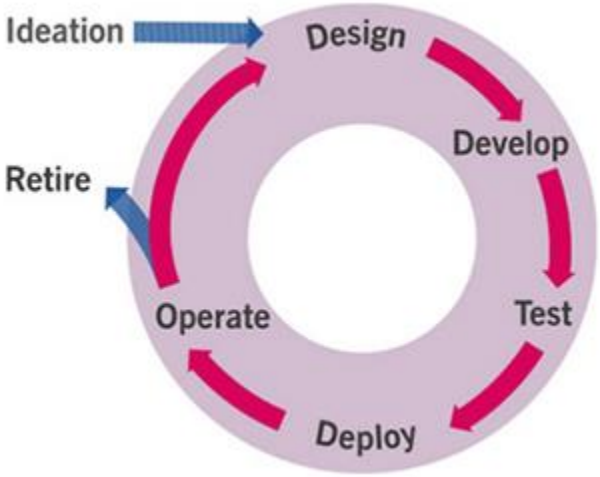

Figure 4: ITIL Software Lifecyle

Figure 3.1 illustrates a typical iteration of the ITIL lifecycle model. Assuming that we are treating TCC's prior process as the "initial" iteration (i.e., the "before picture," as it were), the *ideation* phase began with the adoption of the SC-ELS, which led to coming up with a *design* of the progress reports to accommodate the new guidelines. After the creation of the design, followed the *development* of the first-generation progress reporting process, formed by creating spreadsheets to accommodate the SC-ELS goals and the progress report template. Because this was the initial process developed ad-hoc, there was no discrete *testing* phase in the sense that the developed solution was *deployed* right away, followed by an *operation* phase in which the existing assessment process was used until a point at which it was no longer sustainable due to inefficiency and impracticality stemming from the manual procedures.

With the conclusion of the initial cycle, observations are noted during operation of the current implementation. These comments are then compiled into a list to create the bases of the ideation for the second iteration, at which point TCC began its collaboration with USCB to research and develop a new, more automated process for data collection and analysis.

Second Iteration: Improvements introduced by USCB

The subsequent iteration used the observations made from the previous cycle as the foundational basis for improvement. More specifically, USCB's involvement introduced a more effective method for retention of information, the ability to interpret the data collected, and restructuring the process for better use of resources. Following these ideas as the basis for the next iteration, the ideation stage has been fulfilled.

The second iteration sought the improvement of the objectives set out by the previous iteration, which had addressed those following concerns by the introduction of (partial) automation. The adoption of using a database and database management system (DBMS), along with working with a new group of team members, allowed for overall improvement of the progress report generation process.

With the introduction of the second iteration, TCC had begun working with [several] Computational Science (CSCI) and Information Technology (ISAT) students attending the University of South Carolina-Beaufort. Following the objectives set in place previously, the iteration began by addressing the SC-ELS guidelines and the interpretation of the descriptions. With the vast amounts of goals and sub-goals contained within, the first step was identifying the purpose of the SC-ELS guidelines and its impact within the TCC. Figure 5 presents an abstracted graph representing the relationships the ELS has within TCC's ecosystem.

With an understanding on how the SC-ELS impacts TCC, this triggered the idea of consolidating the vast number of goals and sub-goals. The administrators sought to change the language used by each goal in such a way that one goal contained the actions required to demonstrate two or more sub-goals when possible. Using this method, the goals were also modified to become less subjective.

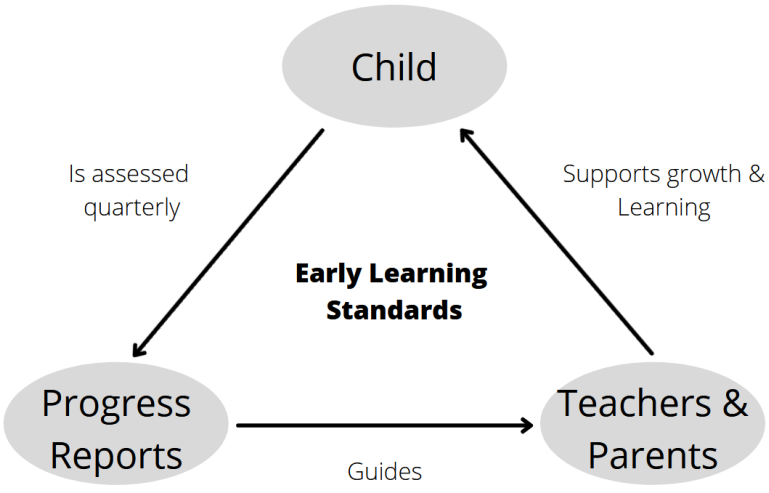

Figure 5: Relationship between SC-ELS and components of the Learning Environment

Lastly, addressing the shortcomings introduced by the current metrics used for tracking progress. Originally the only method to measure progress was by observing the date a child performed a certain task. This means that the only indicator of progress is a task is left blank signaling incomplete, or a date that signifies when this task was completed. However, the issue is in the question “What does complete a task mean? Does it mean doing a task only once or doing a task consistently?”. With the question as the basis for the reconstruction of the metric, three signifiers were adopted. “ / “ for incomplete, “D” for developing mastery, and “M” for mastery. With these metrics in place and when done quarterly, tracking the progress of a child is more effective. This will allow for a more concrete interpretation of goals and progress being made, as well as the benefit of data analyzation using a DBMS.

With the adoption of a database and a corresponding management system, TCC was able to employ the strengths this medium by creating various storage structures to keep all information in categorized folders.

Additionally, the DBMS allows for the creation of *stored procedures*, the ability to create scripts which will pull specific information using parameters such as the ID of a child and the corresponding language the report should be. Another benefit of this system is that when these reports are dynamically generated, the user can translate this information into charts that can be created on a spreadsheet program. This functionality allows for the ability of data analyzation which previously was impractical. Figure 3.3 is a sample report created by utilizing data stored within the database.

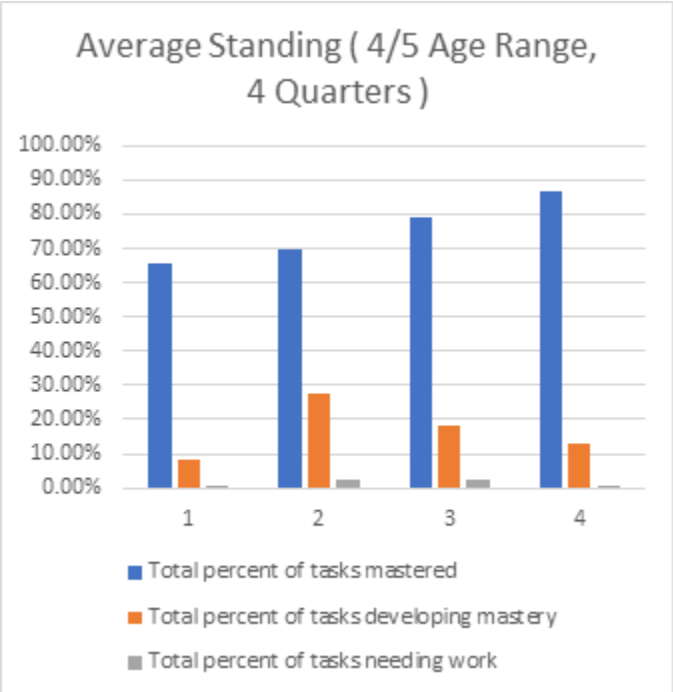

Figure 6: Report tracking progress of children within the 4-to-5-year age group

Utilizing the DBMS's function for stored procedures, this created the concept of dynamic progress reports with a flexible model that can be further worked on to meet additional requirements. As well as using a database with the ability to create various storage containers, the database can contort to the developing demands of the learning environment. Overall, the process of the new implementation has reduced the points of failures by partially automating previously manual aspects. Ultimately, meeting the goals set out by the first iteration.

Discussions

Future Work

With the conclusion of the second iteration comes reflection and observations made while looking at the operation of the model. Although the aspects of progress report generation have been eased, and the ability to analyze information previously unable, the full process still requires the user to maintain a level of technical knowledge. Additionally, the aspect of data entry has still been largely untouched.

With the user having to utilize paper reports and enter the information manually into the DBMS, this process is still time consuming. The user must have a paper copy of the progress report, the DBMS application open, and the spreadsheet application to create reports and graphs.

The shared view of the group is to move forward with creating a desktop user-application which will contain the functionalities involved currently within one application. This would include data entry, progress report generation, exporting progress reports, and data analyzation. Building atop of the previous model yet again.

Lessons Learned / Self-Reflections

The ASEE Mid-Atlantic conference Call for Papers both encourages students to present their school projects, and identifies as a topic of interest *Service and Project-based Learning* (https://sites.google.com/view/asee-midatlantic-fall2021/home). Service and project-based learning are theoretically grounded in Experiential Learning Theory [5], which requires periodical self-reflection (see Figure 7). Included below are self-reflections of undergraduate students who have worked on this project. They are included as they might be of interest to educators seeking to increase empathy with and understanding of undergraduate students studying computer science.

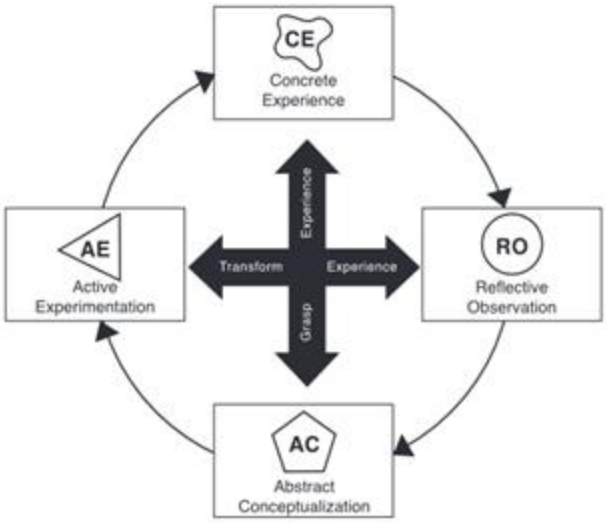

Figure 7: Experiential Learning Cycle

"The experience I had working with TCC was an event that I believe had made me grow as a person both professionally and personally. I had little experience working with real-world situations regarding my discipline. I first started working with them during my Database Management course as a part of our final project and I found myself enjoying the work I was doing. I learned that I enjoyed finding myself working with people and using my time to better assist others in what they do. I then reached out to my professor who had been working with TCC, later began an internship working with them, and finally an independent study to continue working together for my last semester in college. I was able to appreciate the environment of working in a team of people who genuinely care about the work they were doing. I had recently been reading *The Design of Everyday Things* by Don Norman, and I was able to draw from experience inspiration from his human-centered design process on Figure 8."

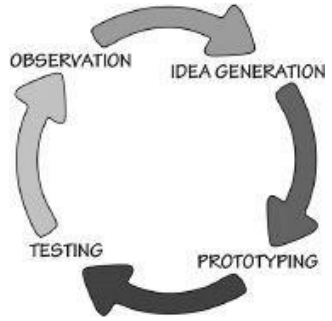

Figure 8: Norman's Human-centric Design Process

I found myself going through similar motions when helping with the design of the dynamically generated reports. Although informal, being able to frame my thinking process was very helpful in identifying or “blocking” steps during the experience. Ultimately, I learned so much and enjoyed the overall process from ideation to operation when working with TCC and hope to continue developing my skills as a developer.

Acknowledgement

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