

Agile development of a whole health system

Steven Sherman
Troy University

Benjamin Larson
Troy University

Jeffery Bohler
Troy University

ABSTRACT

This case is designed to introduce agile development techniques for a systems analysis and design course. Agile development involves more interactions with the end-users of a product. Ideally, a project should work with a real-world organization to develop a solution to an ongoing problem. Unfortunately, this is not always possible as issues with timing or more significant issues such as the Covid 19 Pandemic make coordinating new or existing projects extremely difficult or impractical. This case is designed to allow students to work with a broader section of end-users as most individuals are concerned about their health. The class will design a complete system that examines various aspects of a person's health, including diet, exercise, prescriptions, medical visits, and symptoms tracking. Students should work in teams and coordinate work as a class or a larger team, allowing methods (e.g., scrum meetings) to be implemented while allowing the individual teams to find end users to interview and engage, allowing for growth not only in technical skills but also in soft skills that are necessary for their careers.

Keywords: Systems Analysis and Design, Agile Development, Scrum, Soft Skills

INTRODUCTION

As related to project management, a “scrum” may be briefly described as a set of practices and activities used in agile project management consisting of daily communication, frequent reassessment of plans, and short, iterative phases of work. Activities that involve scrum are more effective in the classroom than traditional lectures (Sibona, Pourreza, & Hill, 2018). Examples of incorporating scrum into a college course include non-programming uses of scrum, agile games, and actual programming projects. It has been established that a hands-on approach with real-world projects is the best way to teach agile methods (Matthies, Kowark, Richly, Uflacker, and Plattner, 2018). However, the degree to which agile is incorporated in these class settings is quite varied.

Previous research has demonstrated the success of scrum in education and adequately demonstrated the viability of the concept. However, they do not give the details necessary for implementation. This paper presents a detailed implementation of teaching scrum in an undergraduate Information Systems [capstone] course. It is a thorough yet abbreviated, use of scrum, including user stories, sprints, Scrum meetings, iterations, coding, incremental deliveries, and project management.

Systems Analysis and Design

Systems analysis and design courses are mandatory in an Information Systems curriculum (Wang, 2015). Historically, two approaches have been taught: the traditional Waterfall methods and agile methods. The 2020 IS model curriculum (Topi, et al., 2010) advises that students should be taught the Systems Development Life Cycle (SDLC) and agile development methodologies.

Agile Development and Pedagogy

Agile project management has become a popular development methodology. Among agile methods, scrum is now in wide use (Sharp and Lang, 2018). Information Systems recruiters and hiring managers have emphasized the need for students with Scrum knowledge (May, York, and Lending, 2016). Because of this, our students must be prepared to operate in an agile project environment when they enter the business world.

Scrum is one of many methodologies and frameworks that fall under the agile philosophy. The four basic tenets of agile place: (1) individuals and interactions over processes and tools, (2) working software over comprehensive documentation, (3) customer collaboration over contract negotiation, and (4) responding to change over following a plan (Beck et al., 2001).

Soft Skills

One of the motivations for this exercise is that it is challenging to learn the concepts of teams and collaboration without hands-on experience (Rush & Connolly, 2020). Collaboration can be challenging in a school setting because our educational system typically measures and rewards individual achievement (Pope-Ruark, 2012). Individual projects do not allow collaboration. However, what activity will engage the student and develop these skills? Agile

methods have been explored as a method for teaching in higher education. Using an agile approach fosters greater collaboration and student engagement (Krehbiel et al., 2017).

In addition to teaching a popular methodology, participating in a Scrum development project is intended to develop 21st-century skills; collaboration, critical thinking, communication, and creativity (Evans, 2020).

THE CASE

The following is the general description of the case and the grade breakdown of the case, which was designed to maximize class interaction during scrum by incorporating a core component that gives a grade to a portion of the work done by the entire class and grading scrum participation. While we utilized a midpoint deliverable and a final deliverable as the primary grading components, each scrum may be used as a deliverable. Additionally, we also use resource management reports to penalize free riders. Our case was designed for a case using the Satzinger, Jackson, & Burd (2015) textbook with the scrums roughly following the chapters covered and would need to be modified to fit other textbooks.

Problem Description

Medical and Fitness industries are a significant part of the world economy. This class is tasked with Analyzing and Designing a system that will track information relevant to an individual. This information may also be helpful to medical practitioners, researchers, dietitians, insurance companies, and personal trainers. In this scenario, imagine that you are an organization looking to benefit from building and maintaining this program for any number of individuals.

The class will be divided into five groups that will work on five standalone modules and create a core for tracking the individual's general health. An additional component of this exercise is to identify shared objects and implement them as a class core. This exercise element was explicitly included to encourage professional behavior and involvement during other group's scrum discussions.

- Core: Shared objects or tables that track general health and infrastructure that need to be shared.
- Module 1/Group 1: Diet
- Module 2/Group 2: Activity and Inactivity/ Exercise
- Module 3/ Group 3: Prescriptions (Medication/devices)
- Module 4/ Group 4: Medical Visits/Medical Records
- Module 5/ Group 5: Symptoms Tracker

Assignment of Points

There will be a final deliverable and several scrum meetings (Each member should plan to be a leader for their group at least once. The class level scrums may either be held separately or with the regular sessions). The assignment points are as follows with the Scrums representing 30% of the total grade with 25% of the grade relating to work done by the class as a whole and 75% related to the work done in groups.

Scrums	30%
Final deliverable and presentation	70%
Group	75%
Class	25%

There can be an Individual Penalty of up to 40% based upon reports from MS Project and peer reviews.

Scrums

Scrums are meant to facilitate communication during development by discussing the results sprints or other work periods so that individuals or teams working on different aspects of a project may convey issues or discuss breakthroughs so that development can be adjusted. During the scrum, the group should discuss what went right, what went wrong, and any obstacles they have that may prevent project progress. While each scrum may vary, teams should order their scrums to follow roughly the textbook used for the course (e.g., Satzinger, Jackson, & Burd (2015)). This case is meant as an introduction so that the iterations may feel more like traditional SDLC until later in the course. Additionally, the instructor should introduce some basic concepts in project management early to be applied throughout the project.

Scrums are usually held daily. For practical purposes, class projects only have scrums on days when classes are in session. While daily sprints are the norm for scrum, limiting meetings to class days has been shown to work effectively (Baham, 2019).

MS Project

Initially, It may be beneficial to walk the students through an example exercise using MS Project or a similar product, allowing students to create Gantt charts and other visualizations to aid in resource planning during their project as shown in Figure 1 (Appendix). MS Project is a popular product in project management, so gaining experience using the software adds valuable experience for the students. The students should enter each scrum as a summary task and material expected to be provided as tasks within that summary task. To identify and penalize social loafing, students must enter who is assigned to work on the task as a resource. In project management, tasks should be assigned and be given due dates based on the estimated time to complete the task. However, students should adjust the project document to identify who actually completed the task to reflect changes from their original plans. As Scrums are an agile development strategy, the deliverables should be adjusted to reflect materials that need to be reviewed or redone. Similarly, students should be allowed to work ahead if it is beneficial to their schedule to complete some tasks earlier.

Operationalizing the Scrums

We present six scrums with suggested deliverables. These examples are not meant to be all-inclusive teaching notes, as this is an agile methodology and the problems change with the feedback provided by the users. Similarly, the scrums we present are not meant to be an all-inclusive discussion of each deliverable but instead illustrate some highlights of representative objectives that the scrum may have, some suggested deliverables, and some general teaching notes.

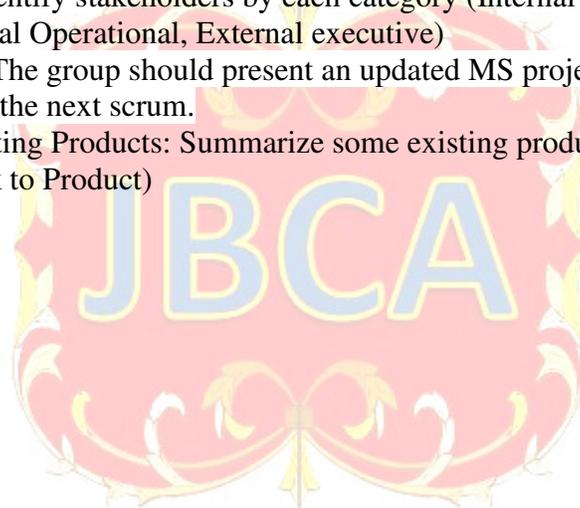
SCRUM 1

Objective

The students should demonstrate a basic understanding of their module, including what problem it solves, and become knowledgeable about who the stakeholders are and what products are available.

Deliverables

1. **Vision Document:** This is a statement of the main problem(s) that your module wishes to address and the system's requirements and benefits. The team should make the program fit as many generic issues as possible, but the team's vision should have a primary focus: performance goals, weight loss, tracking success, or failure of treatments are acceptable examples.
2. **Stake Holders:** Identify stakeholders by each category (Internal Operational, Internal Executive, External Operational, External executive)
3. **MS Project File:** The group should present an updated MS project schedule that includes tasks to complete the next scrum.
4. **Summary of Existing Products:** Summarize some existing products (Strengths, Weaknesses, Link to Product)



Teaching Notes

In agile development, each module needs to respond to feedback from the potential end-users so that various issues may arise. Each instructor should establish what material they want to emphasize for each scrum. For each scrum, we are providing some general teaching notes for some of the suggested deliverables. Early in the process, however, a general direction should be established. The vision document and identifying key stakeholders allow the instructor to help the students avoid scope creep and identify users that the students should involve in the project discussion. The vision document establishes general goals and requirements so that executive funding can be obtained. An abbreviated example of a vision document in Figure 2 (Appendix) shows a framework for how the students may explain the importance of the diet module, some of the key functionalities, and how the project can justify funding. Identifying stakeholders allows the instructor to identify operational users and executive users that the students should visit to establish needed user views. Table 1 in the (Appendix) demonstrates some of the stakeholders that may be identified using a model such as the one represented in the table using internal (Inside the company), External (Outside the Company), Operational (Direct users of the module), and Executive Users (Reports only) allows a thorough evaluation of who has a stake in the module.

SCRUM 2

Objective

The students should demonstrate that they are learning what the users require from their module.

Deliverables

1. Revised Scrum 1 Documents
2. Identify and list the areas of interest for Stakeholders.
3. User Stories (6 Minimum): User stories are simple one-sentence stories stating who the user is, how they use the system, and their goal. It is also wise to gather acceptance criteria as well.
4. Lists of interview questions by stakeholder (Forms and reports from existing products may help)
5. Summary of interviews
6. Summary of requirements (FURPS+): It is suggested to use a tested model to list the requirements. FURPS + (Functionality, Usability, Reliability, Performance, Security, and other factors such as design constraints) is one model that may be used.
7. Use Case Diagrams: Visual representations of who uses the system and the cases in which they use the system, and how the cases relate.
8. Mockup of Reports: This document contains simple mockups of reports representing a user's view and what they may desire to see.

Teaching Notes

The emphasis may focus on gathering information and summarizing them into requirements that the users need. The ability to generate a mockup of reports to allow the group to demonstrate the needed information is critical. We strongly suggest using an organized method to create interview questions. The student must understand that the interviews and feedback from users determine the needed information and business rules created in future scrums. Table 2 in the (Appendix) presents some sample interview questions for the Symptoms Tracker Module. They are grouped by themes and intended to describe the current process, desired process, and the needed information.

SCRUM 3

Objective

The students should be demonstrating knowledge about the information that their module requires to provide the functional requirements. They should be encouraged to begin unit testing to determine if the structure of the data is appropriate. MS Access or some other GUI interface may be used if they are not proficient in quickly creating and inserting records into a relational database.

Deliverables

1. Revised Scrum 2 Documents
2. Entity Relationship Diagrams (ERD): Graphical representations of the entities, attributes, and relationships that will later be used to design the relations within a relational database.
3. Domain Classes and Class Diagram: Similar to ERDs, Domain diagrams represent the information required using universal modeling language (UML). These initial diagrams show relationships and multiplicity but can later be modified to create design class diagrams helpful in object-oriented design.

Teaching Notes

The emphasis should be on the information needed to be stored within the system, the business rules associated with cardinality, and the types of data. The students should match the data stored to what they are presenting in reports and connect information gathered in interviews to both the information and the business rules. Figures 3 and 4 in the (Appendix) show part of the ERDs for the Diet and Prescription Modules, where clarification of instruction of tables or classes that may be shared across multiple tables and combined may occur. The patient and the time and date of when a patient consumes something are recorded in at least two modules. Additionally, the food and drug may be similar in that they are products.

SCRUM 3.5

Objective

A presentation of initial core objects should be presented. Students need to understand that many entities are shared in such a system and that teams should pool their resources to reduce duplication in later stages, which may be done as part of Scrum 3 or 4 or as a separate scrum. Developing the shared core of the project will encourage group participation and professional behavior during all other scrums.

Deliverables

1. Core ERD and Class Diagrams
2. Network Diagrams: Network diagrams show the hardware and protocols needed to connect all the aspects of the system being designed.

Teaching Notes

The emphasis for this scrum should be on the information needed to be stored within the system, the business rules, and the types of data shared by multiple modules. Figure 5 in the (Appendx) represents entities that may be shared across multiple modules from our above examples in Scrum 3. Additional information on nutrient values may be stored in other tables represented as separate entities, subtypes, or classes. While multiple correct answers can be successfully implemented, including keeping food and medication consumption separate, students should be aware that there are advantages to sharing code and other resources when possible. Figure 6 in the (Appendix) represents that part of the core module may be that patients may need others to enter, view, or update their information. Network diagrams may vary widely but often have a cloud component that should be encouraged to explore the needed service level agreement requirements especially connecting them to the requirements outlined in SCRUM 2.

SCRUM 4

Objective

The students should be presenting revisions to their ERDs and demonstrating knowledge about security and integrity controls. They should be able to demonstrate that they have done some testing and have started adding information about security and integrity controls. The students should also start to storyboard required forms and reports to illustrate how the system should function.

Deliverables

1. Revised Scrum 3 Documents
2. Revised ERDs and Class Diagrams
3. Data Dictionary: Data dictionaries provide the metadata associated with the data collected, ranging from data types to security and integrity controls.

Teaching Notes

The emphasis should be on the revised information diagrams while adding additional components that demonstrate an understanding of security and integrity controls. Instructors should also encourage students to perform unit testing when applicable, such as already writing SQL (Structured Query Language) code if using a relational database. The data dictionary may be built into the database, or it may be first worked up in a table that can be used to show the metadata needed as DDL or forms are created. Figure 7 in the (Appendix) shows an initial example. Information such as the Social Security Number should be discussed on whether the information should be entered and the implications of using personally identifiable data (PID), which may prevent people from utilizing the system and should also cause increased data security concerns. A research component on handling personally identifiable information may be added.

SCRUM 5

Objective

The students should communicate a story with their forms and reports and finalize their conceptual database models so that initial SQL may be written.

Deliverables

1. Revised Scrum 4 Documents
2. Forms: The inputs with which the users enter data.
3. Reports: The information outputs that the system provides to the users should improve the system's efficient operation and help solve problems that the user needs to be addressed.
4. Story Board of Forms and Reports.: Details a sequence in which an individual may use the system to solve a particular problem.
5. Feedback from potential end-users.

Teaching Notes

The emphasis may be on the storyboard of the project. For example, part of the group's story may be to track a goal for the percentage of steps that the users had completed for their goal for the group part of the exercise. Simply mocking up the basic flow for how the data is updated and appears will give the user an idea of the potential functionality and be considered a continuous interaction between the users they initially interviewed. The exercise module, for

example, may have a steps goal and a mechanism to track the steps. Figure 8 in the (Appendix) shows a simple mockup of the story of how the program should work. While the students may start the project with such a simple design, they should be encouraged to expand and understand the psychology of design. For example, they may be assigned a research component on the benefits of showing sharing training goals in a social group or as a competition and adding that as an element. Depending on time constraints and complexity, this may be added as future development.

SCRUM 6

Objective

The students should be able to demonstrate that their database is working. If a working prototype of parts of the application is required, they should present their coding related to the forms.

Deliverables

1. Revised Scrum 5 Documents
2. SQL to Create Tables (Data Definition Language (DDL))
3. SQL for Reports: SQL statements to create queries including all the required fields and constraints for the
4. Plan for user testing
5. Plan for deployment (Core should include maps of required infrastructure)
6. Plan for further development

Teaching Notes

The emphasis should be on demonstrating that the SQL will create the database tables as laid out in the final data dictionary and that the SQL for the reports would be appropriate to return the data for the reports. For example, in the graph shown in Figure 8, the SQL should return a steps goal, the number of steps taken, and be constrained in the where clause by a particular patient and date, requiring creating views to query from or unions. The DDL and shared views should be discussed as a class, as this will reduce redundancy, which again may be done as a separate scrum or as part of the final scrum. The plan for further development through a list of added features. For example, they may get to the point of having a form to manually enter steps but not fully integrate uploading data from a wearable device that counts steps. At a minimum, the deliverables provided to this point should allow the creation of the database and allow the project documents to be passed to a project manager for implementation. A system prototype may be created in a less advanced class, which may be continued in a more advanced course.

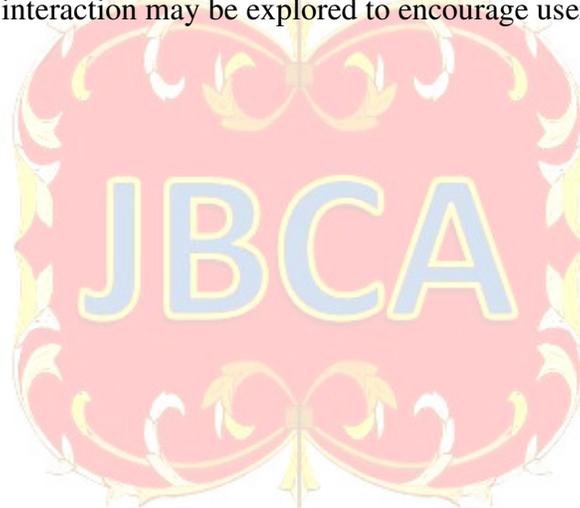
BENEFITS AND LIMITATIONS OF THE CASE

The case can be highly modified and allows access to end-users. The case would allow the class to operate as an organization. However, it does not relate to a particular organization

that provides access to professionals that will provide students with professional feedback. Therefore, the instructor will need to be highly interactive with the group and knowledgeable of the specific techniques for systems analysis and design and, to some extent, the content that should be covered within the modules. The case is also flexible in that it can be adapted to a variety of textbooks and skill levels but requires the instructor to take the lead on project management to prevent scope creep that may take the project beyond the ability and resources of the class.

POTENTIAL FOR CASE EXPANSION

The case may also be utilized by multiple courses, such as using one course to analyze the needs and designing the product and a second course focusing on implementation. Ethics cases on privacy and specific technical aspects such as security, network, and project management may be pulled out and discussed sequentially throughout a program. Concepts such as connecting data from wearable devices may be explored in programming courses and analytics courses if the school's MIS program also has analytics as a critical component. Factors such as human-computer interaction may be explored to encourage users best to meet their health goals.



APPENDIX
Figures

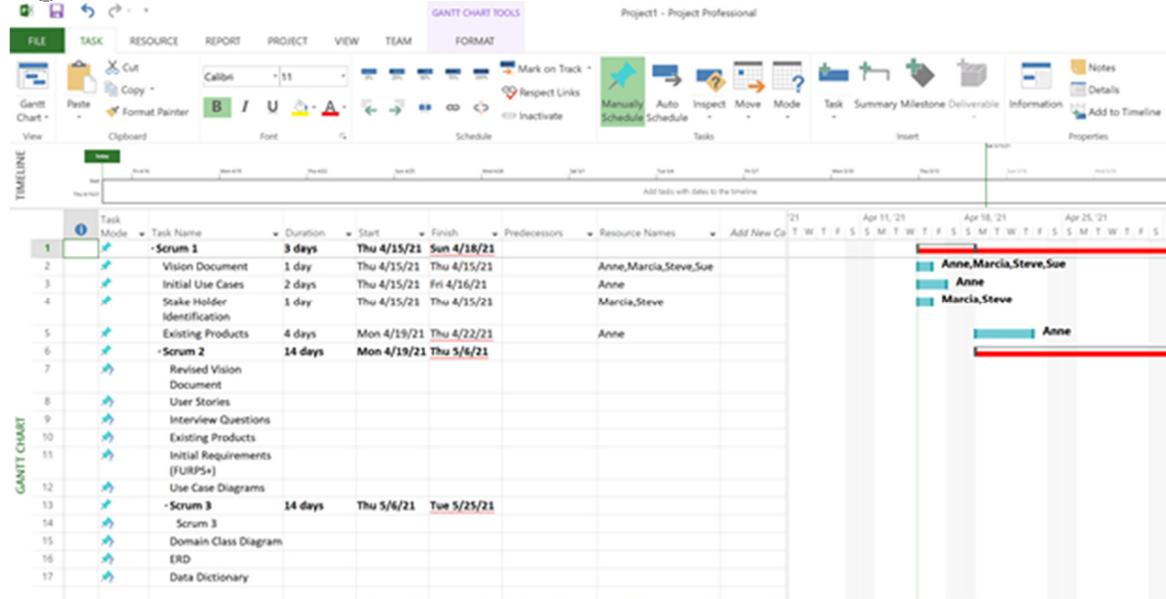


Figure 1. An example Gantt chart from MS Project.

Problem Description

The global wellness industry as well as the food industry represents trillions of dollars worldwide. An individual’s diet has a huge impact on their health and their lives and represents something that every individual has a vested interest in. A whole health system must integrate diet into any program that attempts to help the person be as healthy as possible.....

System Capabilities

- Easy entry of food consumed through mobile devices.
- Ability to enter recipes that provide the nutrient values of food consumed.
- Ability to capture nutrient values of restaurant and manufactured foods.
- Ability to enter goals and constraints and establish alerts as progress towards a goal or constraint is made.
- Ability to provide reports to medical researchers reports about food consumption.

.....|

Business Benefits

- Create ad revenue by promoting healthy food products.
- Provide medical researchers with summarized result to detect the influence of diet on health.

.....

Figure 2. Sample Abbreviated Vision Document



Figure 3. Partial ERD for Diet



Figure 4. Partial ERD for Prescriptions



Figure 5. Partial ERD for the Core Adopted from the Scrum 3 Example

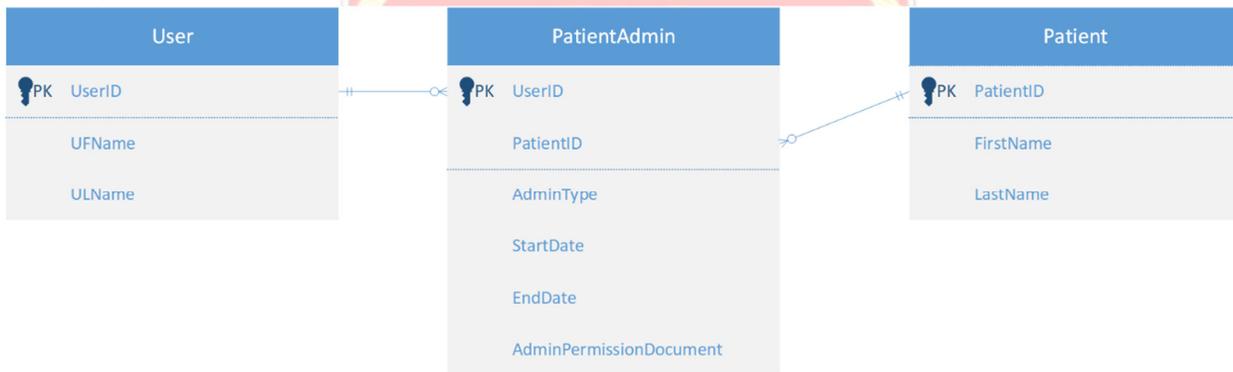


Figure 6. Admin Rights Provided to Other Users

Patient Table								
Personal information of the patient. Captured by the User Entering Patient Information								
Description								
Comments								
Field Name	Data Type	Key	Required	Restrictions	Mask/Input Comment	Example Data	Description	Remarks
PatientID	Int	Primary Key	Y		#####	123456	Identifies Patient	
SSN	INT			Must Be Valid SSN	###-##-####	999-90-9666	Social Security Number	Must be Encrypted
FirstName	VChar (20)	No	Y			James	Patient's first Name	
LastName	VChar (20)	No	Y			Smith	Patient's last Name	
Address1	VChar (50)	No	Y			1219 Highway 231 S	Patient's primary address	
Address2	VChar (50)	No	N			1219 Highway 231 S	Patient's secondary address	
City	VChar (20)	No	Y			Troy	Patient city of residence	
State	VChar(10)	No	Y	Must be a valid state in the U.S	Width to indicate 2 characters	AL	State that the patient is currently residing in	

Figure 7. Example Data Dictionary

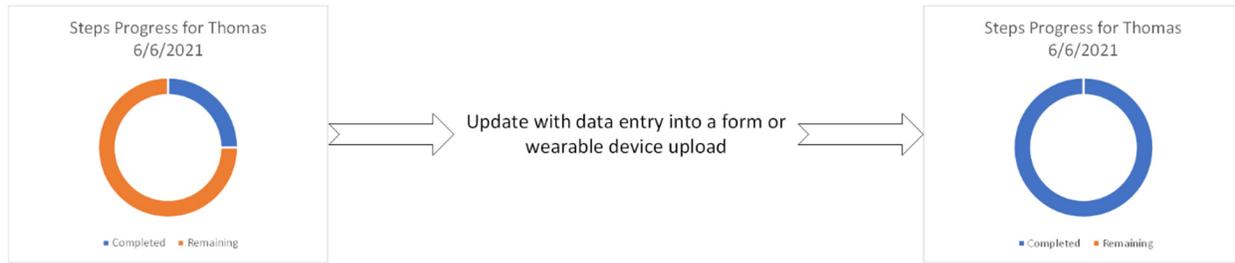


Figure 8. Simple Flow of Step Progress

Tables

	Operational	Executive
Internal	Help Desk, Dietary Support	Marketing Personnel
External	Patients, Parents, Dietitians, Food Providers	Medical Researchers, Medical Staff

Table 1. Sample Stakeholders

Theme	Questions
What are you currently doing?	How are you currently tracking our symptoms? How do you know what to record? What reports are you using now?
How should this be accomplished?	What features would make recording symptoms easier? How might symptom recording be automated?
What Information Is Needed?	What symptoms need to be recorded? What type of data is being recorded? How often are symptoms recorded? Should the same symptoms be recorded many times? What is an example of a symptoms report that you would like to see?

Table 2. Sample Interview Questions by Theme.

REFERENCES

Beck, K., Beedle, M., Van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J., & Thomas, D. (2001). *Manifesto for Agile Software Development*.

Evans, C. M., National Center for the Improvement of Educational Assessment, I. (NCIEA), & PBLWorks (Buck Institute for Education). (2020). Measuring Student Success Skills: A Review of the Literature on Collaboration. 21st Century Success Skills. *National Center for the Improvement of Educational Assessment*.

Krehbiel, T. C., Salzarulo, P. A., Cosmah, M. L., Forren, J., Gannod, G., Havelka, D., Hulshult, A. R., & Merhout, J. (2017). Agile Manifesto for Teaching and Learning. *Journal of Effective Teaching*, 17(2), 90–111.

- Matthies, C., Kowark, T., Richly, K., Uflacker, M., & Plattner, H. (2018). *How Surveys, Tutors, and Software Help to Assess Scrum Adoption in a Classroom Software Engineering Project*. <https://doi.org/10.1145/2889160.2889182>
- May, J., York, J., & Lending, D. (2016). Teaching Tip: Play Ball--Bringing Scrum into the Classroom. *Journal of Information Systems Education*, 27(2), 87–92.
- Pope-Ruark, R. (2012). We Scrum Every Day: Using Scrum Project Management Framework for Group Projects. *College Teaching*, 60(4), 164–169. <https://doi.org/10.1080/87567555.2012.669425>
- Rush, D. E., & Connolly, A. J. (2020). An Agile Framework for Teaching with Scrum in the IT Project Management Classroom. *Journal of Information Systems Education*, 31(3), 196–207.
- Satzinger, J. W., Jackson, R., & Burd, S. D. (2015). *Systems analysis and design in a changing world*. Nelson Education.
- Sharp, J. H., & Lang, G. (2018). Agile in Teaching and Learning: Conceptual Framework and Research Agenda. *Journal of Information Systems Education*, 29(2), 45.
- Sibona, C., Pourreza, S., & Hill, S. (2018). Origami: An Active Learning Exercise for Scrum Project Management. *Journal of Information Systems Education*, 29(2), 105–116.
- Topi, H., Valacich, J. S., Wright, R. T., Kaiser, K. M., Nunamaker, J. F. J., Sipior, J. C., de Vreede (2010). IS 2010: Curriculum Guidelines for Undergraduate Degree Programs in Information Systems. ACM / AIS.
- Wenli Wang. (2015). Lessons Learned from Teaching Project-Based Systems Analysis and Design. *Issues in Information Systems*, 16(4), 132–142.

