System Design Document for "*System for Assisting Instructors in Learner-centered Lesson Design*" (SAIL2D)

Version 1.0

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1. Introduction

1.1. Document Overview

This draft document describes the architecture and use-case of system that is intended to Assist Instructors in Learner-centered Lesson Designer (SAIL2D)
It describes:

- A general description of rationale of building the system
- System level description of the possible functional elements.
- Use-case Scenarios
- Possible future directions for the system

1.2. Purpose of the System

Engineering Instructors in our country do not have a formal pedagogical course, like B-Ed for K-12 schoolteachers, and essentially are untrained while starting their teaching-learning career. Major sources for pedagogical training are short-term In-Service training programs that are organized by premier institutions/their own colleges or online courses (like MOOCs). However these aren't sufficient to sustain the learning benefits post the training.
One possible solution is to engage the training participants in a community of practice where they are provided with systems that allow sharing of best practices.

1.3. Terminology followed in the document

Teachers are the primary consumers of the system and henceforth the document will be using the terminology "*Users*" to refer to teachers. The term *domain* refers to the stream that the *User* is teaching in, for e.g. Electrical, Computer etc. A *course* is a specific subject that the *User* is teaching within his or her own *domain,* for e.g. Data Structures within Computer Science. A *topic* within a *course* is the smallest unit for which an activity will be designed, for e.g. Traversal within a linked list within Data Structures. A User can take more than one *course* and a single *course* can have more than one *topics* under it.
This document contains an accompanying pptx document – **SAIL2DViews.pptx**, which contain an initial design for various screens to be used within this document.

2. Functional Elements of the System

For a system to enable sustained community of practice, we identify the following elements that are of significance:

a) User Creation
b) Personal Teacher Dashboard
c) Activity and Content based View
d) Activity Design
e) Peer Review System
f) Activity Recommender

The various elements of the system are governed by *User*'s *Domain* and *Course.* All the elements discussed above will be governed through a combination of *User-Domain-Course* combination.

User Creation

User creation is the initial registration of the User into the system. The following are the information that is required for a User Registration. (The items marked * are mandatory)

a) User Full Name *
b) Affiliation (Institution Name), with City and State details
c) E-mail id*
d) Teaching Experience * (Options: None, Less than 1 year, 1-3 years, 3-5 years, 5-7 years, 7-10 years, 10+ years)
e) Domain * (Drop down + option to write a new domain)
f) Course * (Should be generated based on Domain + option write new course)
g) Topics * (Should be generated based on Course + option write new topic)

When a User registers he should mandatorily create an activity (Peer Instruction or Think-Pair-Share). After completing this mandatory activity creation, they will be shown their "Personal Teacher Dashboard" (see next page for more info).

A sample template for user registration screen has been provided in the accompanying document – "**SAIL2DViews.pptx**".

Activity Design

In the initial version, the system should support design of two types of learner-centered activities – Think-Pair-Share (TPS) and Peer Instruction (PI). *User*s are provided with guiding prompts and textboxes to create the activity.

TPS has three phases – Think Phase, Pair Phase and Share Phase, each characterized by a guiding question and desired output. PI has four major aspects – Concept being addressed, Conceptual Question, Correct Answer, Plausible Distractors.

A detailed template of the activity views is provided to enable clarity on how *User* provides input to the system. This is an initial version of the view, customizations can happen at a later point based on discussions and suggestions.

TPS Activity

All the elements written in Blue are to be entered by the *User*. The TPS will have

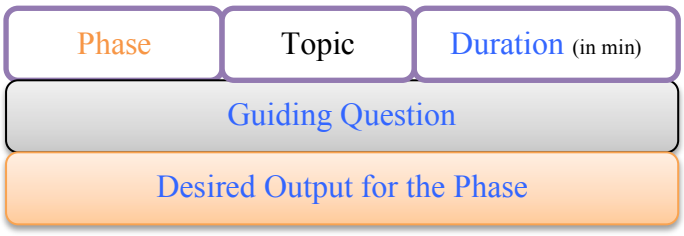

Figure 1: TPS Activity Template

same template for all the three phases – Think, Pair and Share Phase.

PI Activity

A typical PI Activity Screen will have the following template:

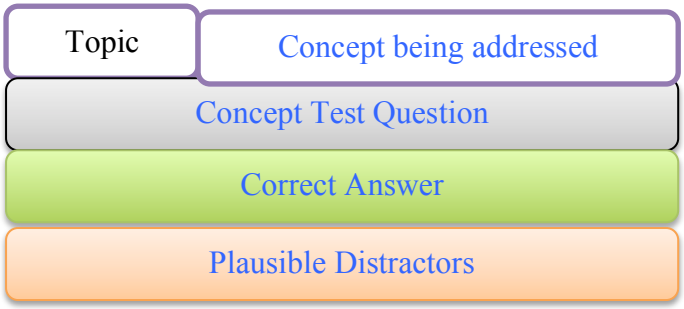

Figure 2: PI Activity Template

Personal Teacher Dashboard

A personal dashboard provides an overview of the system use, but completely personalized. It provides them all the relevant information to the *User* like how many activities have been created, how many have been reviewed and what is the top activity within their own *domain*. The following are the relevant information that should be available within the dashboard.

i. *Domains* for which *User* has contributed till now
ii. *Courses* that are taken by the *User*
iii. *Topics* for which *User* has created activities
iv. *Reviews* done by the *User*
v. *Notifications* on reviews submitted
vi. *User Rating* calculated on the basis of a standard formula

A sample view is shown below (Figure 3). We may decide to add more details as the project evolves.

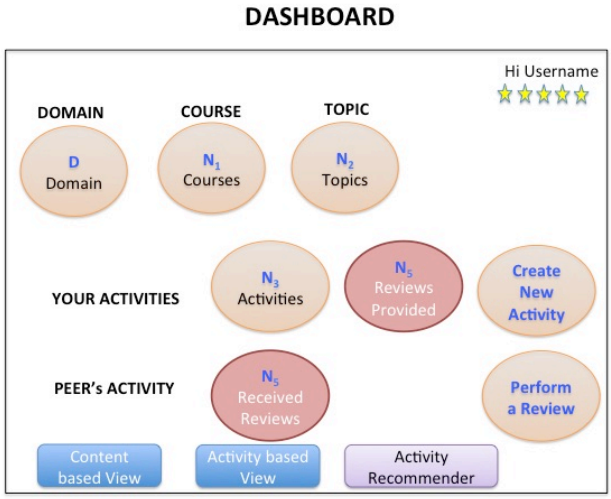

Figure 3: Teacher Dashboard

The elements in Blue will have hyperlinks to the respective section view. The red colour indicates that there are conflicts on the reviews that *User* has to look into.

Views of the system

At the top level User can decide to take two different views of the system –Activity based and Content based View.

In activity-based view the *User* will be able to see the community and resource strength for a particular activity at 3 levels – Domain, Course and Topic. At present there are two types of activities TPS and PI. So the initial screen will show number of TPS's and PI's that are available within the system and number of users generating them (Figure 4). In its next level, there is a *domain* view in which a User will be able to see various domains listed in the system and the number of users under each *domain* for the activity (Figure 5). Each *User* will be able to select only his or her own *domain* to view further. In the expanded *domain* view, the *User* will be able to see various *course*s and number users contributing in each *course* for that activity (Figure 6). S/he will be able to select his/her own *course*s to view further. In the expanded *course* view they will see list of various *topic*s and users contributing to the same *topic* (Figure 7). There are no further expansions possible at this level. Users can go back to the upper level at any point. See the below templates that will provide clarity to the content-based view.

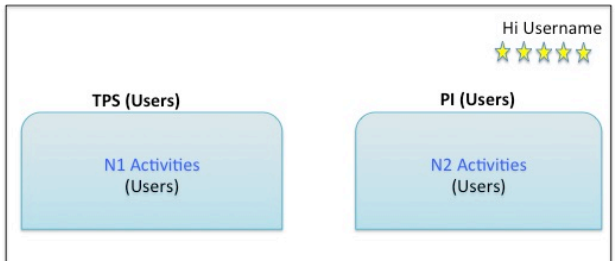

Figure 4: Activity based View - Top Level

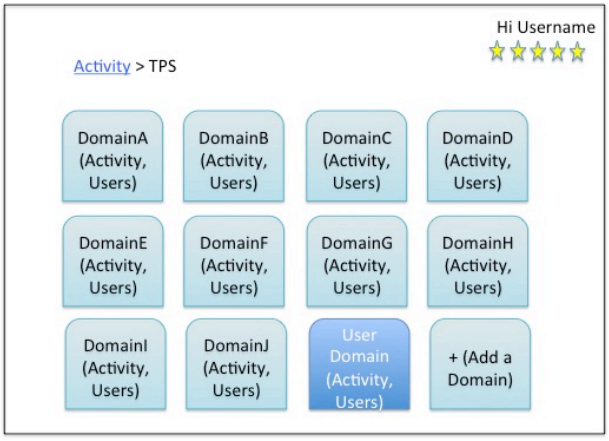

Figure 5: Activity based View - Domain Level

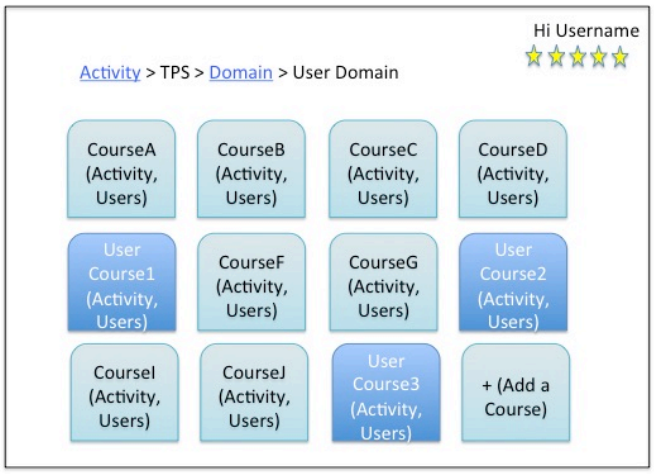

Figure 6: Activity based View - Course Level

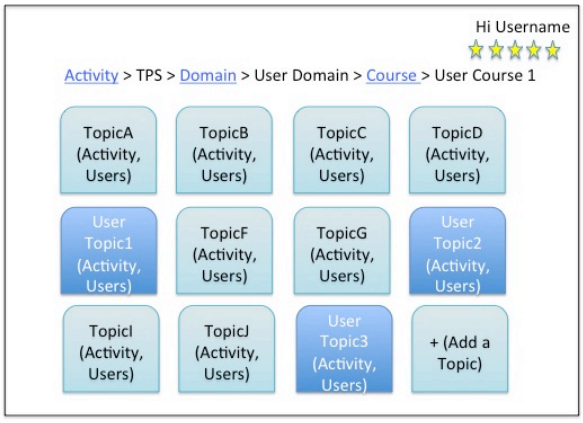

Figure 7: Activity based View - Topic Level

The content-based view provides only the User strength and resource strength at domain, course and topic level. Since these levels form a hierarchy, it is better to give an expandable view at each level.

The final view that is available is the list of all activities within the selection (Domain, Course or Topic or Activity wise) and would be the same in both the views – Slide 17 in the pptx.

Peer Review System

The Peer Review system is the core aspect of this system that allows benchmarking of the activities that are generated by *User* and *User Rating* calculation. All *User*s are by default reviewers also and reviews are assigned on the basis of Domain-Course-Topic or Course-Topic or Domain-Course combinations. There is also a manual review system, wherein *User* can select activities for review themselves.

The *User* is assisted in the process of Peer Review by a rubric (see Table 1&Table 2 given below). S/he has to select an appropriate scale for each of the criteria based on the description given in the rubric. Apart from this the reviewer has to give a detailed explanation as to why s/he gave a particular scale in a given criteria. This has to be accepted by the *User* for the review to be final. If there is a conflict, then it has to be resolved and finalized by both of them for the system to accept the activity. At the end of the review, the *User* is given an option to rate the reviewer based on the experience of their interaction. The *User* can rate both the expertise (based on the rating) and support in conflict resolution (based on discussions).

Thus the Peer-Review system consists of three distinct sub-function elements –Rating Trainer, Activity Rating Accumulator, Disagreement Resolver and User Rating Calculator. The Rating Trainer provides *User* with example activities that have been rated by expert for practicing rating. The Activity Rating Accumulator just assigns the initial rating and notes the review comments. The conflict resolver is an asynchronous discussion board (or more like threaded forum) between the *User* and reviewer.

A detailed description of the review is provided in the Use-case Scenario.

Rubric for TPS

Given below is the rubric that is used for rating a TPS activity.

Table 1: TPS Evaluation Rubric

Criteria/Scale	*Unsatisfactory (0 point)*	*Needs Improvement (1 point)*	*Satisfactory (2 point)*
Aptness for Think Phase	The Think Phase activity is broad, hence all students will not be able to attempt this activity.	Most of the students will be able to write a response to this T-Phase activity, however there will be some who will not be able to attempt this.	The Think Phase activity is broad enough that all students in class are able to write a response.
Time for Think Phase	The time required for Think Phase is either not mentioned or is too large that students will get bored.	The time required for Think Phase is slightly high (greater than 3 minutes) and this may cause completed students to be restless and bored.	The Think-Phase activity is designed to be completed in 1-3 minutes so that all students are able to complete the activity.
Necessity of Pair	The Pair Phase activity can be done by an individual and does not require a pair		The Pair Phase activity requires a pair to perform this activity and cannot be

			done by an individual alone.
Time for Pair Phase	The time specified for Pair Phase activity is insufficient to complete discussions.	The time specified for Pair Phase activity is slightly high (greater than 8 minutes) which will make students go off-topic after their discussion is over.	The time specified for P-Phase is between 5-8 minutes that allows sufficient discussion to happen without students going off-topic.
Link between activities	The activities between the Think-Pair-Share phases are not connected at all.		The activities/questions in the Think-Pair-Share phases are well connected.
Deliverable in each phase	There are no concrete outputs in any of the Phases.		There are concrete deliverables at the end of Think, Pair and Share phases.

Rubric for PI

Given below is the rubric for evaluating a PI activity.

Table 2: PI Evaluation Rubric

Criteria/Scale	*Unsatisfactory (0 point)*	*Needs Improvement (1 point)*	*Satisfactory (2 point)*
Stimulate Discussion among students	All students have a clear idea about the concept, resulting in zero discussion.	Majority of students have a clear idea about this concept, and hence there will be less discussion.	Most students would have misconceptions about the topic and a question like this elicits multiple answers and hence stimulates rich discussion
Have plausibility of choices	The student can eliminate all the choices except the correct answer.	There are few choices that can be eliminated immediately, resulting in evaluation of just 2 choices.	The choices in the PI are plausible and directly target the possible misconceptions. Students will not be able to answer by elimination.

Disagreement Resolver

The conflict resolver comes into picture when there are disagreements between *User* and Reviewer about a particular review. With respect to a *User* there can be two types of conflicts:

a. Disagreements on reviews received on *User*'s activity
b. Disagreements on reviews submitted by *User*

Both the cases will show a Disagreement Resolution Interface which contain the following details – List of Activities for which conflicts have come, Type of Activity (PI/TPS), Created by, Reviewed by, Number of Disagreements, Reasons for Disagreement (see below). Both the User and Reviewer have options to provide justifications as well as modify the rating based on justifications to reach consensus. Screen flow for disagreement resolver is given in the pptx document.

User rating Formula

The *User Rating* is calculated based on the accuracy and extent of Peer Review done by the User. The User rating is a 5-Star rating based on a 2-point score, calculated based on number of activities submitted by User. If R_{ij} be the final rating of i^{th} User Activity given by j^{th} reviewer, E_j & CS_j be the expertise and conflict support rating given by the jth User:

$$S = \left\{ \frac{n - \sum_{i=1}^{n} \left(\frac{\sum_{j=1}^{m} R_{ij}}{m} \right)}{n} \right\} + \left\{ \frac{\sum_j \left(\frac{E_j - E_{min}}{E_{max} - E_{min}} + \frac{CS_j - CS_{min}}{CS_{max} - CS_{min}} \right)}{2r} \right\}$$

If D_k be the rating of k^{th} dimension given by a reviewer for an activity out of the n dimensions with D_{kmax} and D_{kmin} being the maximum and minimum scores possible for this dimension, then R is calculated as:

$$R = \frac{\sum_{k=1}^{n} \frac{D_k - D_{kmin}}{D_{kmax} - D_{kmin}}}{n}$$

The grades for each star is as given below:

$$\begin{cases} S = 0 \,; No\ Star \\ S < 0.50; 1\ Star \\ 0.50 \geq S < 0.90; 2\ Star \\ 0.90 \geq S < 1.35; 3\ Star \\ 1.35 \geq S < 1.75; 4\ Star \\ S \geq 1.75; 5\ Star \end{cases}$$

For e.g. consider the below scenario:

U_1 has created 2 TPS and 1 PI activity that has been reviewed by 3 peers each. S/He has also reviewed 5 PI and 3 TPS activities of peers. The following table shows the various ratings at the end of the review cycle.

Table 3: Example Ratings for a User

For U_1	On User's activity			On User's Review (E, CS)				
TPS1	U_2	U_3	U_4	U_3	U_4	U_7	U_8	U_9
	1,1,2,1,2,2	2,2,2,2,2,2	1,2,2,1,2,2					
TPS2	U_2	U_4	U_7	1,2	2,2	2,2	2,2	0,1
	1,1,0,1,0,0	1,1,2,1,2,2	2,1,0,2,2,2					

PI3	U_2	U_5	U_6	U_4	U_4	U_6
	1,2	2,2	2,2	1,2	2,2	0,0

$$R_{12} = \frac{\sum_{k=1}^{6} \frac{D_k - 0}{2 - 0}}{6}$$

i.e R_{12} = (1/2+1/2+1+1/2+1+1)/6 = 4.5/6 = 0.75
Similarly R_{13} =1, R_{14} = 0.83, R_{22} = 0.25, R_{25} = 0.75, R_{26} = 0.75
Now for PI,

$$R_{32} = \frac{\sum_{k=1}^{2} \frac{D_k - 0}{2 - 0}}{2}$$

i.e. $R_{32} = (1/2 + 1)/2 = 1.5/2 = 0.75$
Similarly $R_{35} = 1$, $R_{36} = 1$

So the total score would be, $S = \left\{\frac{3 - \sum_{i=1}^{3}\left(\frac{\sum_{j=1}^{8} R_{ij}}{8}\right)}{3}\right\} + \left\{\frac{\sum_j\left(\frac{E_j - E_{min}}{E_{max} - E_{min}} + \frac{CS_j - CS_{min}}{CS_{max} - CS_{min}}\right)}{2*8}\right\}$

i.e.

$$S = \left\{\frac{3 - \left({}^{(0.75 + 1 + 0.83 + 0.25 + 0.75 + 0.75 + 0.75 + 1 + 1)}/_{8}\right)}{3}\right\} + \left\{\frac{0.5 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 0 + 0.5 + 0.5 + 1 + 1 + 1 + 0 + 0}{16}\right\}$$

or $S = 0.705 + 0.75 = 1.455$ ➔**4 Star Rating**
The system should have capacity to store both the score and star rating.

Activity Recommender

Recommender system is for mere consumers of activities. In the current version, this will be available by Recommend Users can select activities from a combination of (Domain/Course/Topic) and:

a) User Rating (i.e. Number of Stars)
b) Individual activity's average User rating ($Ravg = \frac{\sum_{j=1}^{m} R_{ij}}{m}$)

In case a particular combination does not have any activity till now, it should be shown using Red. A sample template for the activity recommender is shown below (Figure 8,Figure 9,Figure 10&Figure 11) in sequence. Please note that the Screen 4 table values will change based on the earlier selection. The current table contains maximum number of columns that can be listed in the recommendation. The "Read more" in Figure 11 will provide a view of the activity (See Figure 1 or Figure 2)

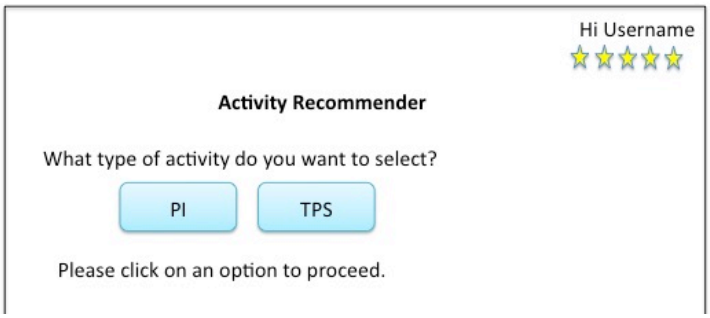

Figure 8: Activity Recommender - Screen 1

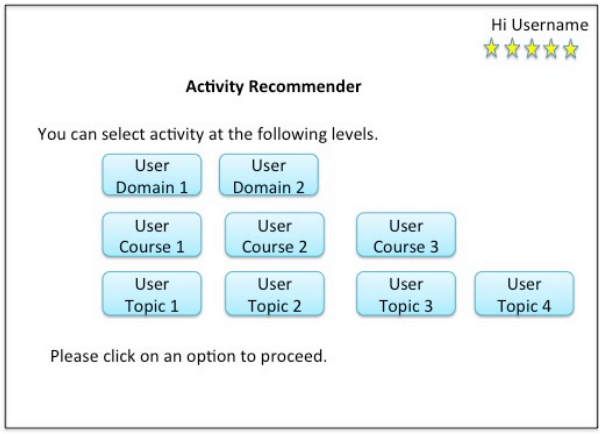

Figure 9: Activity Recommender - Screen 2

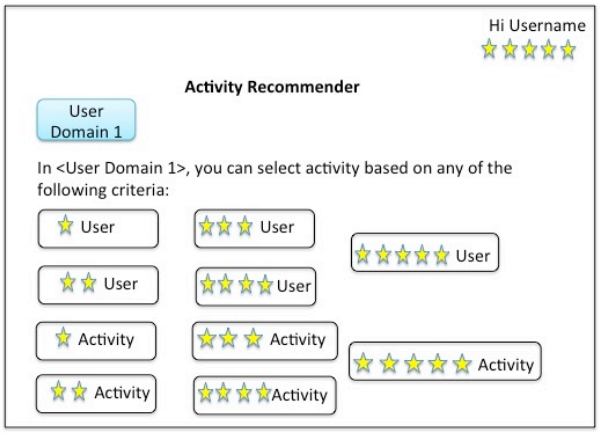

Figure 10: Activity Recommender - Screen 3

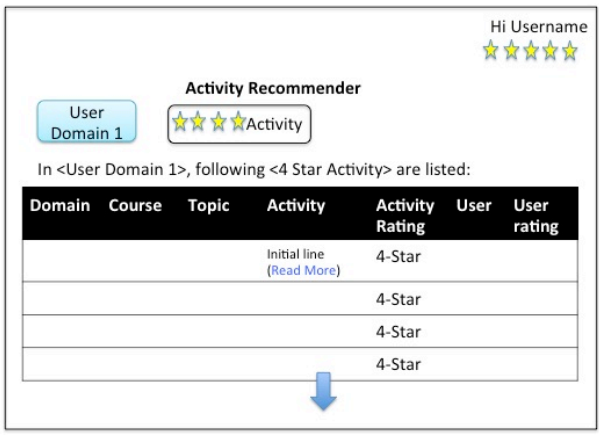

Figure 11: Activity Recommender - Screen 4

3. Use-case Scenarios

Here we describe a set of use-case scenarios that a typical User will go through.

A. When User registers to the system
   Step 1: Show the registration screen, details are collected
   Step 2: Creates first activity (see steps in B.a or B.b)
   Step 3: Shows Personal Teacher Dashboard

B. When a registered user signs into system for creating a new activity
   Step 1: Show Personal Teacher Dashboard.
   Step 2: User Clicks "Create New activity"
   Step 3: Activity Creator Screen 1 asks what type of activity User wants to review
   a. New TPS activity
      i. Activity Creator – Screen 2.1 (in pptx) is shown
      ii. *User* completes Think-Pair-Share phases
      iii. Submits using submit button
      iv. System asks whether he wants to create a new activity
      v. If yes go back to Step 3, else go back to dashboard
   b. New PI activity
      i. Activity Creator – Screem 2.2 (in pptx is shown)
      ii. User completes PI question and options framing
      iii. Submits using submit button

C. When User logs in and wants to review an activity
   Step 1: Show Personal Teacher Dashboard
   Step 2: User Clicks "Perform a Review"
   Step 3: Activity Review Screen 1 asks the type of activity that needs to be reviewed
   a. TPS activity
      i. Option for selecting an "Allotted activity" or select activity at Domain/Course/Topic level associated with the Reviewer.
      ii. If Allotted activity is selected go to iii below. If Domain/Course/Topic level is selected, list of all activities corresponding to that level is displayed. Reviewer selects the activity that he wants to review.
      iii. Shows the TPS activity designed by another *User* (anonymous). Review rubric criteria are shown. If this is his first review, he has to mandatorily undergo training. Else it is
      iv. Steps in Training
         1. Example submission appears.
         2. Grading criteria is shown, select one score.
         3. If Reviewer score matches with expert score message is shown, along with expert feedback. Proceeds to next criteria

4. If Reviewer score is not matching, then error message is shown, highlighting user choice. Reviewer must repeat steps till match with expert is achieved

v. Now grade the activity based on each of the criteria. For each review criterion, feedback has to be provided (1-2 lines).

b. PI activity

Steps are similar to the ones given in TPS. The only difference is in the type of activity.

D. When User receives feedback on his/her activity
   a. User clicks on "Reviews Received" in Personal Teacher Dashboard
   b. Goes to Disagreement Resolver Interface.
   c. Selects the activity for which feedback is provided.
   d. Sees the ratings and explanation (Screen 2.3 – slide 38)
   e. Marks the ratings with which there is agreement.
   f. Explains reasons why there is disagreement
   g. Clicks Confirm
   h. Goes back to Disagreement Resolver Interface
E. When User receives disagreement on their Review
   a. User clicks on "Reviews Provided" in Personal Teacher Dashboard
   b. Goes to Disagreement Resolver Interface
   c. Selects the activity for which disagreement has been noted.
   d. Identifies Criteria for which there is disagreement (Screen 2.1 – slide 36)
   e. Clicks on "Expand" button to see Original Feedback and Points of disagreement
   f. Now User can act on the points of disagreement by changing his original rating or providing counter arguments.
   g. Clicks Confirm
   h. Goes back to Disagreement Resolver Interface
F. When user wants to view a list of activities based on activity type
   a. Clicks on Activity based view in Personal Teacher Dashboard
   b. Activity Viewer asks the type of activity (Screen 1 - Slide 9)
   c. Shows the different domains (Screen 2 – Slide 10)
   d. User selects the domain
   e. User sees various courses under selected domain (Screen 3 – Slide 11)
   f. User selects the course
   g. User sees various topics under selected course (Screen 4 – Slide 12)
   h. User selects topic
   i. Display shows all set of activities under the selected topic (Screen 5 – Slide 13)
G. When user wants to view a list of activities based on content type
   a. Clicks on Content based view in Personal Teacher Dashboard
   b. Sees the types of activities in his/her domain (Screen 1 – Slide 14)

c. Expands selection by selecting Activity type
d. Sees different courses under the domain (Screen 2 – Slide 15)
e. Expands selection by selecting course.
f. Sees different topics under the domain (Screen 3 – Slide 16)
g. Selects the topic of choice
h. See list of activities under the topic (Screen 5 – Slide 17)

4. Future Directions

The current functionalities of the SAIL2D are very limited and offers design opportunities of two learner-centered activities – TPS and PI. Also the current version is a centralized unit, which means that every *User* needs to access the main system for creation and review. Three possible future directions of this product could be:

a. Inclusion of more learner-centered activities.
b. The idea of a Client-Server/Cloud-based version of this system.
c. Creation of a competency profile of Users based on activity quality.
d. A richer Analytics Admin Dashboard that will allow System admins to gather insights about User participation.
e. Report Generation for administrative activities.

The current design should enable addition of these extensions in the updated versions.