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Purpose

The purpose of this literature review is to identify how higher order thinking (HOT) skills are defined and measured so it can inform the choice of HOT skills I will study and how they can be measured in my proposal.

What are higher-order thinking skills?

HOT skills are difficult to define [1], [2]. Lewis and Smith [1] set out to define and differentiate it from other commonly used terms, critical thinking and problem solving. The authors discuss the humanities' focus on critical thinking in the evaluative sense and science and mathematics focus on problem solving, noting that while each domain may focus on certain skills both are needed in all disciplines.

King et. al. [3] in a thorough review of the major learning theorists' concepts of HOT also notes the importance of researcher objectives in influencing the definition and effecting confusion. In the end, however, they cite Lewis and Smith's definition [1] and expression of value as the best:

Higher order thinking occurs when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations. A variety of purposes can be achieved through higher order thinking as defined above. These would include: deciding what to believe; deciding what to do; creating a new idea, a new object, or an artistic expression; making a prediction; and solving a nonroutine problem.

After examining definitions and various taxonomies the authors enumerated the situations, skills, and outcomes of higher order thinking. Some situations leading to development of HOT include ambiguities, challenges, confusions, and problems involving skills such as complex analysis, reflection, systems analysis, and synthesis. Example outcomes include arguments, confirmations, hypotheses, plans, and solutions.

Resnick [2] also defines higher order thinking similarly as Lewis and Smith and provides more detail about what it looks like, noting that "... although we cannot define it exactly, we can recognize higher order thinking when it occurs." Notably she describes it as being "nonalgorithmic" often having "multiple solutions" that require "nuanced judgment and interpretation" and often involves "uncertainty." The process is one of "imposing meaning," which is an "effortful" process requiring "self-regulation." Finding one all-encompassing definition may not be reasonable and is likely not the place to start when assessing HOT skills; models are the level at which skills should be defined. [4] The next section is an overview of a few well known models including their intent when created and general structure.

How do you measure higher-order thinking?

Bloom's Taxonomy

While the authors discussed previously tend to refer to HOT in similar ways, there are frameworks that have been developed that can be used as jumping-off points for measuring the exhibition of HOT skills. In general, frameworks vary in their nature of HOT skill measurement and intent for use and there are many more than what is discussed here. However, these are discussed as they were often referred to in the literature.

Bloom's taxonomy which took eight years to develop, first appearing in 1956, originated from a desire to share test items between faculty at different institutions and developed into a classification of educational goals and objectives. [5], [6] The taxonomy covers three domains: cognitive, affective, and psychomotor; for the purpose of this literature review the focus here will be on the cognitive domain. The framework was revised in 2001 to a two-dimensional scale containing knowledge and cognitive process. Behaviors can now be classified according to the knowledge required: factual, conceptual, procedural, and metacognitive and the cognitive

process used: remember, understand, apply, analyze, evaluate, and create. The cognitive process is defined as hierarchical with higher levels subsuming lower levels implying more complex processing requires mastery of less complex processes. However, there is some evidence that HOT is not necessarily hierarchical. [2], [7]–[9]

Ennis' Critical Thinking

Ennis does not use the term higher-order thinking, but uses critical thinking instead, making the tie between higher-order thinking and critical thinking by referring to some peoples' definition of critical thinking as being composed of the top three levels of Bloom's taxonomy: analyze, evaluate, create. His purpose for defining critical thinking was for developing proper assessment, which he says is not facilitated by the vaguely defined categories in Bloom's taxonomy. [9]

Ennis' model contains 4 categories of critical thinking – clarity, basis, inference, and interaction. Clarity relates to indicators such as asking and answering questions for clarification and identifying assumptions. Basis pertains to evaluating evidence and providing support for reasoning. Inference includes induction and deduction as well as the evaluation thereof and “making value judgments.” Interaction means working with others to identify action(s) and evaluating outcomes. [4]

Solo Taxonomy

The SOLO model, developed in 1982, is based on Piaget's definition of the cognitive stages of development. It consists of 5 different stages of increasing structural complexity: prestructural, unistructural, multistructural, relational, and extended abstract. Prestructural is the lowest stage defined by student responses indicating a non-understanding of the problem. Unistructural is characterized as having a surface understanding with “one relevant aspect” of the problem

realized by the student. In multistructural more than one substantive aspect of the task is understood, however no relationship is formed; this is and lower levels are considered surface approaches. Multistructural is likened to Bloom's procedural level. When students can relate the pertinent information in the task into a whole the relational level is reached, and when that whole is expressed as a higher abstraction the extended abstract is attained. [10]

Garrison's Community of Inquiry

Garrison's Community of Inquiry model arose from a need to help structure education experiences online as higher education began to use computer-mediated communication (CMC) for distributed learning purposes. [11] The model consists of three components that are necessary for successful learning when education is conducted in a CMC environment: social presence, cognitive presence, and teaching presence. Social presence relates to the ability for the learner to develop an identity within the community. Cognitive presence is the ability of the community members to be able to construct meaning through the CMC environment. Lastly, teaching presence consists of instructional design and facilitation of the learning process and supports the cognitive and social aspects.

Since this review is concerned with HOT, only the cognitive presence dimension will be discussed in detail. The cognitive presence element is called the Practical Inquiry (PI) model in Garrison's framework, named as such because it is based on Dewey's concept of practical inquiry, which relies heavily on reflection. Because of a socio-constructivist approach to the educational process the model in general is described as having an "iterative and reciprocal relationship between personal and shared worlds." [11]

As with the Bloom and SOLO taxonomies it consists of multiple phases. The process begins with a triggering event which generates a state of unease such as a problem, confusion, or

question. Exploration is the second category and may involve looking for more information about and/or discussing the details of the triggering event. Integration, the third category, is about digesting the information to formulate an overall idea or concept. Lastly, resolution is an attempt to apply ideas to resolve the issue and critically evaluate solutions.

How have higher-order thinking frameworks been applied?

While free and open source software (FOSS) communities have been studied on many dimensions such as member characteristics, project characteristics, social processes, software development processes and FOSS use [12], there appears to be no research concerning exercise of higher-order thinking as a participant in FOSS. Such information would point to the potential for students to exercise those skills through participation in FOSS. As such, this became one of the research questions in my prospectus. So, to inform the methodology for study of HOT in FOSS my literature search turned to studies examining those skills in domains with similar characteristics.

This research review is primarily related to study of HOT within online educational environments and application of HOT frameworks to defining software engineering skills. HOT skills in online education was chosen because the area I plan on eventually studying, FOSS, has some characteristics in common with online educational environments; FOSS uses threaded discussions as does the studies reviewed and both are socio-constructivist learning environments. [11], [13]–[15] Furthermore, the studies discussed here all pertain to undergraduate and graduate students so it is applicable to the learner of interest. Skill identification in software engineering using cognitive frameworks was also reviewed because work in that domain is similar to OSS.

All the studies related to online education used content analysis as the major investigation mechanism. Themes that emerged related to conducting the content analyses were: 1) selection of the right model(s) for the domain and measurement of quality, 2) unit of analysis; and 3) exogenous factors that influence HOT exercise and measurement.

Model choice considerations

Herrington and Oliver [8] in studying the ability to exercise HOT in a class using multimedia for education of pre-service math teachers first began with enumerating the characteristics of HOT as defined by Resnick [2], then corroborated HOT definitions from various theorists, and then identified indicators for each category that characterized how students in the study would communicate. He found evidence for HOT in 70 percent of talk coded from transcripts of videotapes. The high percentage related to other studies discussed in this review might relate to the data evaluated, transcripts of videotaped interaction with the tool versus distributed online discussions.

Research related to individual engagement in critical thinking online [16], [17], also blended models and studied the domain for indicators. Perkins and Murphy [16] created a simple model consisting of 4 phases: clarification, assessment, inference, and strategies. While Garrison's PI model was considered it was not chosen as the sole framework because the authors' purpose was studying individual engagement in critical thinking not in the online community as a whole. Despite the research focus, however, results were presented on group and individual levels. For the group studied discussion focused mainly on clarification and least on strategies. Examples were presented showing how the model can be used to compare individual students.

In a study of critical thinking in an undergraduate online math problem discussion board [17], the Perkins and Murphy model was used as a base and then indicators were developed from the

domain of math problem solving and then qualified using Paul and Elder's qualities of an accomplished critical thinker. [18][4], [7] Like Perkins and Murphy the authors found on a group level most postings were in the lower levels of HOT -- clarification and assessment -- while individual-level analysis showed varying levels of HOT engagement within categories.

Other examples of a multi-model approach were by McLean and Newman. [4], [7] As Jacob and Sam [17] did, McLean used Paul and Elder's intellectual standards for critical thinking: clarity, accuracy, precision, relevance, depth, logic, and breadth as part of a mixed-model approach to the analysis of critical thinking quality in an undergraduate correspondence psychology course. Two models were used, one with the standards for quality and another for measuring critical thinking: clarification; making inferences and interpretations; supporting inferences and interpretations; making value judgments. Results showed that the quality of critical thinking was in line with other studies of critical thinking in undergraduate students, low to moderate. Critical thinking areas that were not displayed often included "supporting inferences and interpretations" and "making value judgements."

Newman et al. was also interested in measuring quality, but also interested with how HOT was demonstrated in online and face-to-face discussions. He studied students examining controversial issues in IT and society. For this he combined models of Henri, who identified criteria on which to evaluate the cognitive dimensions of CMC, and Garrison because, in his opinion, Garrison's model aligns most closely to Henri's and relates to the social meaning construction that occurs in group critical thinking processes. However, to factor in quality Henri's model was also used to measure depth of cognition leveraging a list of paired opposites that describe surface processing and deep processing indicators. The authors used that as a starting point to create their own paired indicators, such as "Offering judgments or solutions

without explanations or justification” and “Justifying solutions or judgments.” Results from analyzing tape-recorded seminars and computer conference transcripts showed similar ratios for critical thinking in both face-to-face and computer conferencing. However, computer conferences showed more information linking behavior and less generation of new ideas. The authors point to the computer conferencing system used that made it easier to review previous messages before responding, making it easier to integrate ideas than in a face-to-face discussion.

Meyer [19] also investigated the differences between face-to-face and online discussions with regard to demonstration of HOTS skills, but among graduate students in an educational leadership class. However, to determine the differences a student questionnaire was given instead of conducting a content analysis of tape recordings of face-to-face seminars. This reflects the difference in what the authors were measuring with regard to comparing the mediums, quality of critical thinking versus favorability for learning. Meyer used the PI model solely during the content analysis and found similar results to Garrison when he employed the model, a low number of resolution-type postings. In line with findings by Newman et al., that new ideas were generated more often in brainstorming, Meyer reported that certain types of activities, such as brainstorming and topics benefitting from high energy and excitement, appeared to work better face to face. Likewise, it was reported that topics requiring reflection may work better in an online discussion, which reflects the findings of Newman et al. of more integration in the online setting.

While Schrire [20] did not use a multi-model approach, she did examine the viability of different models for categorizing individual and socially-distributed cognition. She used interaction pattern maps combined with three models of cognition—Bloom’s taxonomy, SOLO taxonomy, and the PI model -- to investigate the relationship between individual and socially-distributed

cognition among doctoral students using asynchronous online computer conferencing in a technology in education class; she considered Bloom's and Solo to be individual cognition models. In her analysis she found a number of different message patterns including scattered, message chains, and instructor-centered. When comparing categorizations among the three different models roughly half to two-thirds of the messages showed evidence of HOT. In general for individual cognition, the models performed similarly. However, the PI model may be more apt to identify cognitive processes in group contexts as there appeared a stronger relationship between interaction patterns and cognition than with the SOLO and Bloom taxonomies.

While individual and socially-distributed cognition was a consideration by some in the choice of framework, another factor considered was applied versus abstract definition of cognition. For instance, Jacob and Sam noted that the educational definition of problem solving did not consider ill-structured problems that occur in real-life and therefore was not suitable. [17] Garrison [21] when addressing possible issues with his own results from applying the PI model mentioned its appropriateness in that it reflected real-life situations versus other models that were "...based on abstract logical thinking processes, such as deductive thinking and analysis of arguments, with little consideration of critical discourse." And, in the process of trying to apply Bloom's taxonomy for identifying skill levels of undergraduates in software engineering and experienced software engineers, it was reported that as the taxonomy stood it was not relevant given its focus on scientific not operational processes as in software engineering and that it was never intended to be used outside teaching. [22]

Units of analysis

Across the papers various units of analysis were used. For instance, Schrire in her case study approach used multiple units of analysis from examining the computer conference as a whole to

the discussion thread to messages to speech segment and used interaction pattern mapping to help identify threads of interest. Herrington and Oliver examined various methods for identifying the appropriate unit of analysis considering analysis by individual words, categorization by passage, each student utterance, and unit of meaning. The individual words approach didn't apply since the task was to identify themes. Passage categorization was abandoned because of difficulty identifying when one passage ended and another began. Utterance wasn't used because at times various turns of talk included multiple category types which made simple counting of the most important category problematic because it may be misleading. Unit of meaning, or each instance of a type of talk, was the approach decided upon because it captured types of talk that may have been missed by the other methods. Perkins and Murphy and Jacob and Sam followed the same approach and in the case of possible multiple categorizations took the predominate or most important meaning. Newman et al. also coded by unit of meaning but counted only obvious examples, avoiding grey areas to make the assessment task easier, but allowed the coding of multiple categories in a unit as did McLean.

Meyer, who used the PI framework, used the same unit of analysis as Garrison did when he tested his framework, coding a student's entire message in a thread. Garrison's rationale for using the message as the coding unit was based on a number of reasons. First, it was clearly identifiable by the coder, unlike other units, even sentence-level units. Second, sub-message units make the process more onerous as each coder must decide on it. Lastly, the message content and length is determined by the author not the coder. When multiple phases or contradictory phases were encountered, Garrison used a process of coding down when the phase was unclear and coding up when multiple phases were present.

Noting that Garrison had not intended for the PI model to be “immutable” and lack of further testing of the model since first introduced, Fahy looked to apply and refine the PI model. [23] In addition, he wanted to compare results from applying the PI and Transcript Analysis Tool (TAT) for identifying, among other things, cognitive presence. The choice to make a comparison was based on concerns that the PI model was not suitably complex, noting that compared to transcript analysis studies in general the PI model’s four phase approach was seen as “relatively low” and there were issues with the message unit level of analysis and the coding up and coding down process used. In addition, Fahy notes that Garrison traded off accuracy for reliability when Garrison suggests, “Submessage level units [ie, sentences] may be introduced in future confirmatory studies if increased precision is warranted.”

The TAT was adopted to address the concern of accuracy although while trading off simplicity and reliability. It involves coding at the sentence level into one of 8 categories, of which five are major categories: 1) questions (horizontal or vertical), 2) statements (referential or non-referential), 3) reflections, 4) scaffolding comments, or 5) paraphrases and citations. Sentences can be coded into one or more categories. In making the comparison it was expected that each tool would show facets of behavior that the other did not. In this subject population, students in a graduate credit online course, the proportions in the given phases of the PI model were similar to the original study, with exploration accounting for a substantial portion of the messages.

What the TAT model did show was insight into the other category of the PI model, revealing social and network functions to be a large part of this category. Also, trigger postings tended to have fewer sentences than exploration and resolution, as one might expect. Lastly, when analysis is performed at sentence level it may show communicative strategies used during critical thinking as part of the community of inquiry.

Exogenous factors affecting higher-order thinking exercise and measurement

When Garrison conducted the initial pilot of the PI model he was struck by the low proportion of responses in the integration and resolution categories. In his discussion he offered that possibly the model was not appropriate, but also that the instructional design and facilitation of the course and the computer conferencing tool used could also be factors. Meyer in noting similar results to Garrison expands on that list to include the complexity of the issue and student skill in formulating and testing resolutions.

These factors point to the instructional environment and student predispositions as factors that influence the exercise of HOT behaviors online. The measurement difficulty is further compounded by the difficulty of trying to assess individual thought processes, which is an inherently subjective process, and the extent to which students make cognitive presence available in online discussions. As such, Garrison recommended using triangulated measures to supplement the transcript to provide more accuracy to the interpretation. [21]

Methodology

Choice of Framework

In setting out to examine HOT in my own participation in the AnkiDroid project and from postings on the OpenMRS mailing list, I originally thought I should consider the intent of the framework at conception and whether it was intended for individual or socially-distributed cognition as some of the authors discussed. However, after trying to use that as criteria it seemed like an ineffective way to make a choice. What arose from the articles was that behaviors will be different in different domains and tasks. What seemed important was to be able to identify the behaviors representative of the domain, categorize them and then place them within a framework.

However, starting at an initial point of pouring over the data to derive behaviors from the ground up seemed like overkill given that some of the frameworks discussed so far provided fodder from which to start. So I decided to pick and choose elements from looking across the frameworks discussed (See table 1.) that I thought may pertain to the domain and tasks of interest to begin my initial analysis. In the end though I chose the framework used by Jacob and Sam [17] because it focuses on problem solving, which I thought may relate well to tasks in FOSS communities. (See table 2.)

Although I started from an existing framework, this is just as a first step to deriving a method to measure HOT in FOSS community artifacts. In the end the framework and associated indicators will morph into something different as this should be an iterative process until there is adequate coverage of the indicators representative of the domain and the thinking process becomes more well understood.

Table 1. Elements of models used by the authors discussed. (doesn't reflect a mapping between categories.)

McLean	Herrington and Oliver	Jacob and Sam/Perkins	Fahy/Garrison/Meyer	Newman et al. (Used paired indicators based on Henri's pairs related to)	Azuma (Modified Bloom's taxonomy)	Schrire
Clarification of the thesis, problem, or question	Social	Clarification	Trigger	Relevance	Knowledge of	Coded using multiple models (Bloom's, Solo, and Garrison)
Making inferences and interpretations	Procedural	Assessment	Exploration	Importance	Comprehension of	
Supporting inferences and interpretations	Lower Order	Inference	Integration	Novelty	Application (tried as in case of students)	
Making value judgements	Higher Order (all that follow) Uncertainty	Strategies	Resolution	Bringing outside information in to help address the problem	Application (in case of experienced)	
	Path of Action			Ambiguities	Analysis	
	Judgment			Linking ideas, interpretation	Synthesis	
	Multiple perspectives			Justification		
	Imposing meaning			Critical Assessment		
	Metacognition			Practical utility		
				Width of understanding		

Table 2. Model for identifying engagement in critical thinking during problem solving

Clarification			
Formulates the problem precisely and clearly.			
Analyses, negotiates or discusses the scope of the problem	Identifies one or more underlying assumptions in the parts of the problem	Identifies relationships among the different parts of the problem	Defines or criticizes the definition of relevant terms
Assessment			
Raises vital questions and problems within the problem.			
Gathers and assesses relevant information.	Provides or asks for reasons that proffered evidence is valid or relevant.	Make value judgment on the assessment criteria or argument or situation.	
Inference			
Reasons out based on relevant criteria and standards			
Makes appropriate deductions from discussed results.	Arrives at well thought out conclusions	Makes generalizations from relevant results.	Frames relationships among the different parts of the problem.
Strategies			
Thinks and suggests open mindedly within alternative systems of thought.			
Propose specific steps to lead to the solution.	Discuss possible steps.	Evaluate possible steps.	Predicts outcomes of proposed steps.

Source: Jacob, S. M., & Sam, H. K. (2008). Measuring critical thinking in problem solving through online discussion forums in first year university mathematics. In *Proceedings of the International Multi Conference of Engineers and Computer Scientists*.

Unit of Analysis

To test out using the framework in table 2, I tried applying it to my own logs of tasks I'd undertaken on the AnkiDroid program and a very small sample of discussions (5) on the OpenMRS Developers' and Implementers' mailing lists. The purpose was to explore what kinds of higher-order thinking occur in performing tasks and identify areas that are problematic in using the framework.

To begin I copied the blog postings I used as a log of my activity on the AnkiDroid project and postings that showed at least a moderate level of activity on the OpenMRS mailing lists to separate Word documents. I then read them over and used the comments function in Word to code a passage relating to a behavior(s) in the framework.

I used the unit of meaning as the unit of analysis, not the sentence-level as in Fahy or message unit as in Garrison. This was because sentence-level was too fine-grained; I was not interested in the method used for providing basis, but instead that they were doing so. I did not use message-level because from my own experience reading mailing list postings I thought that multiple categories of behavior may occur in a message unit. Lastly, to help avoid inferring meaning on the postings to the mailing lists, I tried to stick to coding just obvious indicators as did Newman et al. Unlike some studies where the purpose was to quantitatively measure the extent of HOT that was not my purpose. I was only interested in identifying such behavior so coding just the obvious indicators made the task easier and minimized the chances of me inferring some behavior incorrectly, but with the tradeoff of possibly missing examples of indicators of interest.

Results

AnkiDroid (Individual problem solving)

Below presents some coding results from my work on AnkiDroid. This reflects individual cognition and is not what I would expect to see on mailing lists when people work on tasks. Generally, this type of behavior would probably be best extracted from students keeping diaries of work on the project. While not shown here the process of documenting steps in a log may work to help build to students to help exercise metacognition and self-reflection, which some of the authors [3], [8] in this literature review mention as HOT skill.

Here is a segment from attempting to install an emulator so I could run AnkiDroid on my laptop. The problem was that the instructions for creating an sdcard to be used by the emulator did not work (codes are in bold):

[after trying to run the command in the instructions to create the sdcard] So I went to the directory I created in #1 and did not find it there. Then for some reason, I went to windows file explorer and noticed I couldn't find c:\documents and settings\ to look for the file there. I was confused. How could I see that folder at the msdos prompt but not in windows explorer?

1. So, I Googled where is the location of documents and settings and in windows 7 and found that it no longer existed. **(Assessment)**
2. That made me think the reason I couldn't create the img file using mkcard was due to trying to create a file in a subdirectory no longer used by the OS. **(Inference)**
3. So, then I just created a SDK-1.0 directory as directed in #1 in a directory I could see in Windows explorer. At this point, i was concerned about problems with Anki running given the img file was not in the directory stated in #1, but I decided I'd worry about that later and just try and get the emulator working. So I ran the mkcard command above using the directory I created and their filename and it worked. **(Strategies)**

Here is an example of problem solving when attempting to load a deck of flashcards in the AnkiDroid software to view in the emulator:

1. I Googled "failed to copy 'collection.anki2' to 'test': Read-only file system" and got back alot of pages pertaining to anki, including one talking about changes to anki 2.0. I thought that might be useful to look at later. My gut was telling me to look more at problems that could go wrong with adb push. So, I then googled, adb push failed to copy: Read-only file system. I got back some tips pertaining to mounting the file system, making sure I had the right permissions, making sure I had the right adb driver. These seemed to be pertaining to mounting a specific device not using the emulator. **(Assessment)**
2. Somewhere along the way I came across this page (<http://ankisrs.net/docs/SyncingMedia.html>), which made it sound like I do have to use Anki2. **(Assessment)**
3. I decided to uninstall the old version of Anki and reinstall Anki2. I then downloaded a deck and synched it with the Anki2 site. From there I started the emulator and chose to sync my decks and my deck finally showed up.

What is shown here above with regard to HOT is that uncertainty and ambiguity lead to having to draw inferences so one can make a decision (strategies) on how to proceed. Prior to drawing the inference this is not possible without assessing information. In example 2, step 3 while there was a decision to try the approach discovered in step 2, I did not code it a strategy because after reading step 2 there no longer seemed to be an uncertainty that required an inference. I am uncertain whether that is necessary for coding a decision on how to proceed as a strategy. One could say it is strategy because it has to be evaluated/tested as to whether it works (of note, there was conflicting information on the web site) or because possibly inference is not a necessary step. This leads to a question as to whether assessment, inferences and strategies only occur if the prior stage is completed.

OpenMRS (Socially-distributed problem solving)

Below presents some example results from OpenMRS mailing list postings. The following thread shows a discussion related to a person not being able to find the right place to create a trouble ticket. What starts out as a simple request for the right location eventually leads to a discussion about design. (codes are in bold, author names appear before text):

Suranga:

I was trying out the access Logging module (
<https://wiki.openmrs.org/display/docs/Access+Logging+Module>)
Unfortunately, it seems that the module has not been updated to OMRS 1.8.X.

I tried installing it, but ended up with the same error as mentioned by Dimithri here - <https://answers.openmrs.org/questions/535/error-in-using-the-module-because-detected-attempt-to-redefine-the-prefix-form>

I'd wanted to create a ticket for this (and hopefully, also fix it), but I cant seem to find the Access Logging module on the OMRS jira project list. **(Clarification)**

Is there a particular reason this is missing from JIRA, or am I looking in the wrong place ? (**Assessment**)

Ben:

If a module doesn't have a jira project of its own you should file it in the OTHER project: <https://tickets.openmrs.org/browse/OTHER>

The <https://wiki.openmrs.org/display/docs/Reporting+Bugs> wiki page also points at the simple bug reporting page on the main openmrs site for other kinds of generic errors. It will be triaged and moved to the appropriate place. <http://openmrs.org/help/report-a-bug/> (**Clarification**)

Suranga:

Thanks Ben, I've gone ahead and created the ticket (<https://tickets.openmrs.org/browse/OTHER-22>)

Rowan:

Mark can confirm but I think all access logging module functionality ended up in the usage statistics module (**Clarification**)

Ben:

Hi Rowan,

The wiki page confirms that this is indeed the case. Thanks for pointing this out, it makes my job much easier ! :-)

Mark:

Yes, we should probably move the Access Module into the "abandoned modules" section. (**Strategies**) The access module functionality was never directly moved into the usage statistics module, but, to the best of my knowledge, they do similar things, and the Usage Statistics in is the one that we are currently supporting. (**Inference**)

If there are no objections, I'll move Access Module wiki page into the abandoned modules section tomorrow...

The example below involves a knowledgeable user who has found a problem with a new version of the software and works with a developer to find a strategy for how to fix.

Lara:

PIH Rwanda is planning on upgrading to openMRS 1.9 (from 1.6) in June of this year. We are currently investigating an issue with 1.9 (we are testing against RC3) and the Reporting framework (latest version). We are currently investigating the issue, but this one is an absolute show stopper for us and will prevent us from upgrading, so if anyone has any suggestions that would be greatly appreciated.

Currently we create our report definitions in code and save the whole report definition without saving the individual components of the report definition (because we use sync to propagate our report definitions to child servers, so it makes life a lot easier if there is only one row in the serialized object table that needs to be propagated, rather than rows for each individual indicator etc). We currently use the ReportDefinitionService saveDefinition method to save the whole report definition. This works fine for 1.6, however running the same code (and versions of the reporting framework) don't work for 1.9. In 1.9 instead of objects like the DataSetDefinitions and Cohorts being serialized as part of the report definition, instead they are referenced within the report definition as if they have been saved independently (which they have not been). **(Clarification)** This means that the report definition saves just fine, however doesn't run because it can't find the necessary objects it references with the definition. **(Clarification)**

I have attached a copy of the content of the serialized_data column in the serialized object for the report definition as it is saved in 1.6 versus 1.9 so that you can compare the difference in behavior.

If anyone has any idea what has changed with the serialization or hibernate interceptors etc which could explain the behavior we are seeing, it would definitely help us out. **(Assessment)**

Michael:

I have not yet looked into this yet at all, but my guess is that this is due to the fact that we now set uuids on OpenmrsObjects when they are instantiated, rather than when they are saved to the database independently. I am guessing that the Xstream Serializer is serializing the full nested definitions including the uuid, and then when it tries to deserialize this it is looking at the uuid attribute and if it is present it is trying to load the nested definition from the database, and if it is absent it is constructing it from the serialized data. So our xstream serializer is assuming that the presence of a uuid on the definition indicates that it is independently persisted. **(Inference)** This is where we will likely need to make the fix... **(Strategy)**

The last example is a posting for feedback on design of a new registration module. The author who started the discussion adds to the request the need to find more information on other similar efforts to avoid duplication of effort and leverage existing work. What follows are excerpts from the post showing inference and strategy skills used in design and generating an action plan for how to learn what developers of other registration modules are doing.

Wesley:

Hello fellow OpenMRS developers!

My name is Wesley Brown and I am writing on behalf of the OpenHMIS team to get some feedback on the design for our Registration Module. **(Clarification)** The OpenHMIS Registration Module is the entry point of the data for all of our patient-related activities. All forthcoming OpenHMIS modules that deal with patient data will rely on this registration module in some fashion, if only for the data that is collected. As such, the registration module functionality will likely grow to support the additional interfaces and requirements over time.

The features that will be included in our initial release are:

- Gather Patient Registration Details
- Support Multiple Registration Queues (e.g. Inpatient, Outpatient, etc)
- Gather Patient Visit History
- Patient Visit Slip Generation
- Support Flexible Patient Queries
- Patient Data Lifetime
- Registration Notifications
- Support for Patient Sponsorship
- Appointment Scheduling
- Patient Record Accessibility

Each of these features is discussed in more depth on our wiki

page: <https://wiki.openmrs.org/display/docs/OpenHMIS++Registration+Module>

The OpenHMIS code is currently hosted at

github: <https://github.com/OpenHMIS/registration> Note that the features above have not yet been implemented so there isn't very much in the way of code to look at.

It seems like there are a number of groups working on adding more robust registration capabilities to OpenMRS, as well as other hospital management features. I have heard of at least two: a group from PIH and a group from AMPATH. However I have not been able to find any public information about their progress or overall design.

(Clarification) Has there been any discussion about collaborating with each other so that

we don't duplicate our efforts and end up with a bunch of fragmented HMIS modules? If not, is there any interest to do so? **(Assessment)**

We would also like to get some feedback from the OpenMRS development community and hopefully utilize existing work rather than reinvent the wheel. **(Clarification)**

Thanks!
-Wes Brown

Burke:

Wesley,

Thank you for this message. There have been many registration-related efforts over the years (e.g., amrsregistration, registration, remoteregistration, and rwandaprimariycare modules represent some of these). Most of these share some fundamental traits, but were created as separate projects because of varying requirements, for lack of resources for the extra effort needed to collaborate, or simply for lack of coordinated efforts). It would be wonderful to start converging on the basic registration functions needed and get these into a registration module that can be shared. Since most of the modules have different requirements/dependencies at the UI layer, one approach might be to try to create a registration module that focuses on providing the registration service (API functions) needed across most/all registration applications (finding a unique patient, tools to find/avoid creating duplicate patients, registration-specific events like providing a hook for other modules to listen for registration events and/or sending out an HL7 ADT message upon registration, etc.). **(Strategies)** While there might be a single registration application (UI) that would meet most needs, it may be more effective to start by tackling the smaller task of creating the fundamental services/pieces needed across registration applications and thereby creating a module all other registration modules could use as a foundation from which they could focus solely on implementation-specific UI needs. **(Inference)**

My assumption would be that some of these services would need to provide hooks for implementations to insert their special sauce. For example, provide default algorithms for searching for a patient and for searching for potential duplicate patients, but expose hooks that implementations (or other modules) could easily adjust or replace these algorithms to meet their local needs. **(Inference)**

So, you may consider splitting your module in two: focusing the collaborative effort on creating a foundational registration module upon which multiple implementation could share the load, and then creating the rest of the functionality you need in a module that depends on this first module and implements the features for which you may have a harder time finding collaboration opportunities. **(Strategies)**

This sounds like a potential topic for an upcoming forum. Maybe a message to the implementers list to locate people with existing solutions, interest, ideas that could be

consolidated within an [OpenMRS Forum](#). Then adding this to an agenda or two of future design forums. (**Strategies**)

Cheers,

-Burke

Conclusion

With regard to the framework, I had difficulty keeping the categories clarification and assessment separate. What I decided upon was that clarification related to just the elements and relationships of problem as it stood, basically anything related to problem identification. For assessment, I made a point to separate “gathers” and “evaluates” within “gathers and evaluates relevant information.” I thought knowing when to look for additional information was an important skill and should be captured and I didn’t want it to be missed if in the discussion the person who posed the question did not evaluate it. In my interpretation in the situations I was coding, assessment meant looking for more information to close the gap of uncertainty and evaluating that information (e.g., credible, logical, relevant) as to whether it helps close the gap. While the framework described inference as “reasons out based on relevant criteria and standards,” in all the cases there were no “official” criteria or standards. In this case, to be coded as inference the reasoning had to be substantiated in a logical way.

What this simple test showed was that the model used in table 2 can be used to identify HOT processes, however, further testing needs to be done using more data across different FOSS projects with multiple coders to help mitigate subjectivity. Furthermore, data from different FOSS projects should be examined to identify indicators representative of the domain for the categories used in the framework; this will assist with the coding task. Given that HOT is a latent variable the use of triangulation possibly through interviews and questionnaires of FOSS participants can aid in increasing accuracy of measurement. Lastly, higher-order skills such as

reflective thinking not mentioned in the framework explicitly may be evident in discussion postings, but more likely evident from individual student diaries if used during the process of participation in OSS.

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