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Investigating the Role of Students' Feedback-Seeking Actions in Harnessing and Adapting to the Distributed Competence

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Abstract: Feedback-seeking actions are student-initiated dialogic actions directed at meeting their diverse needs concerning the teacher's instructional activities. Distributed competence refers to the notion that knowledge, skills, and perspectives needed to accomplish the goals of particular activities are distributed amongst individuals and tools of the community. The focus of this study is in contrast to the predominant educational practices related to feedback and competency development. Existing feedback practices and research primarily focus on what and how of providing feedback to students with only limited attention to facilitating student-initiated feedback-seeking. Besides, feedback interventions targeting competency development focus on improving individual performance by encouraging comparison or competition amongst each other. However, given the rapidly changing human activities where even well-regarded knowledge, skills, perspectives, and tools become obsolete, being proactive and cooperative in harnessing and adapting to the distributed competence takes the center stage. Therefore, we investigate the possible role of students' feedback-seeking actions in harnessing and adapting to the distributed competence. Our findings reveal the processes by which students' feedback-seeking actions contribute toward harnessing and adapting to the distributed competence in a particular instructional activity of significance. The study involved two groups of chemistry students working on a complex representational problem pertaining to the synthesis of an important medicinal drug. The findings are relevant for future research on designing sustainable classroom instructions and CSCL environments.

Keywords: Case study, undergraduate chemistry education, student agency, feedback as dialogue, feedback-seeking, distributed competence, cultural-historical activity theory, and microgenetic analysis.

1. Introduction

Prevailing educational practices related to feedback and competency development are largely informed by behaviorist and cognitivist perspectives (Hodges, 2018; Lipnevich & Smith, 2018). Within these practices, the focus is predominantly on providing unilateral feedback to students with only limited attention to facilitating student-initiated feedback-seeking. Effects of these feedback-provision-interventions are found to be inconsistent and at times even negative (Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Shute, 2008). Consequently, these feedback provision focused practices are considered unsustainable and detrimental to students' agency (Boud & Molloy, 2013). Moreover, the root cause behind these problems is traced to the lack of appropriate theory and gaps in key interconnected notions such as instruction, feedback, and competence. Existing ideas of these notions do not account for multiple cultural factors such as student diversity, teacher workload, and shortage, competence in the context of teams, evolving tools and workplace conditions, and the scale of educational challenges before governments. Besides, the interplay of cognition, emotion, motivation, and identity aspects of students also remains ignored. Against such a backdrop, we identified cultural-historical activity theory (CHAT) as a valuable theoretical lens.

CHAT is an interdisciplinary approach currently studied and applied in both education and workplace contexts (Engeström, 2018). It views any human activity as a goal-directed collective system mediated by cultural factors such as tools, representations, norms, community, and the nature of

cooperation. It recommends viewing any chosen human activity as situated within a web of interconnected human activities. If we consider instructional activity, then its practices have to be viewed in relation to other interconnected activities such as students' families, educational institutes, industries, and government. This is in contrast to standard research approaches viewing instructional activities in isolation by black-boxing many other interconnected societal issues. As a result, CHAT helped us consider and address multiple issues discussed previously. Given below is the reconceptualization of key notions followed by the discussion on how CHAT helped inform them.

- The instructional activity is a teacher's predetermined plan involving the organization of certain tasks, tools, representations, norms, individuals, and ways of cooperation (division of labor) estimated to support students' learning towards particular valuable outcomes.
- Feedback is any information concerning the given instructional activity that addresses students' needs tied to their knowing, doing, or being for accomplishing, modifying, or even avoiding the aspects of instruction. Students can derive feedback either by observing or working with tools, representations or having a dialogue with themselves and multiple others or using a combination of these modes.
- Students' feedback-seeking actions are those actions where decisions such as purpose, timing, mode, amount of feedback-seeking, choice of feedback source, and how feedback is used are all made by themselves.
- Competence is an evolving set of interconnected knowledge, skills, and perspectives needed to accomplish the goals of activity or cluster of activities grounded in relevant societal contexts. Aspects of competence are distributed within and beyond the elements of instructional activity.

In the above definitions, the idea of instruction acknowledges the complexity of any goal-directed human activity as informed by CHAT and does not reduce it to just tasks or talk like a set of problems or lectures. Further, instruction as an estimate and predetermined plan accounts for classroom realities such as student diversity, teacher workload, and large pupil-teacher ratio. Consequently, we also do not view teachers' role as orchestrating instruction and feedback on a moment-to-moment basis. Then the idea of feedback acknowledges that it can be any information that meets students' diverse cognitive, emotional, motivational, identity, and behavioral needs. Especially, viewing feedback's role as not always accomplishing the goals of instruction aligns with the notion of instruction as an estimate where it may or may not address students' diverse needs. This along with the idea of students' feedback-seeking extends the scope for students' agentic actions. That is, students can choose to seek feedback from multiple sources and through multiple modes for accomplishing, modifying, or even avoiding the aspects of instruction. Such conceptualization aligns with CHAT's perspective on viewing learning as a joint transformation of not just individuals but also activities (Engeström, 2018). This is also unlike many prevailing practices where teachers initiate and drive feedback events even when peers exchange feedback.

The focus on students' feedback-seeking aligns with Nicol's (2013) emphasis on getting students ready for life beyond university, like occupational settings where feedback seldom comes from others proactively. Instead one has to identify potential sources from the community and elicit feedback from them. Also, feedback received in such a manner can be vague, ambiguous, and even conflicting. Hence, feedback received has to be subjected to rigorous evaluation. Compare this with the formative feedback guidelines in education which require an external agent such as a teacher to continuously monitor student performance, simultaneously account for various student and task characteristics, and accordingly adapt the content, mode, timing, and frequency of the feedback messages to be provided (Shute, 2008). Lastly, the idea of competence acknowledges that it is not an isolated set of stable skills but one that can also become obsolete with the changes in particular activities within which it is situated. This is because as activities change by incorporating novel tools, representations, norms, and ways of cooperation; some of the prevailing knowledge, skills, and perspectives may become redundant. Moreover in simple, routine, and standard activities competence may appear as situated within an individual or tool, however, in complex activities, it is very often distributed amongst multiple individuals, tools, and artifacts (Engeström, 1992; Rogoff, 2003). Together, these notions help inform the investigation of our research question i.e., How do students' feedback-seeking actions help them harness and adapt to the distributed competence?

2. Methods

To answer the above research question, we identified and gave students a representational problem adapted from Wong, Sultana, & Vosburg, 2010. It pertained to the synthesis of an important medicinal drug 'Warfarin' (refer to *Figure 1*). Choice of the problem was informed by the CHAT's view that 'knowledge worth learning is continuously evolving'. While there were other methods of synthesis, the particular technique underlying the chosen problem is precise, cheap, fast, and environment-friendly. The underlying technique 'asymmetric organocatalysis' is well-recognized in chemistry for its significance in current and future pharmaceutical research and green chemistry.

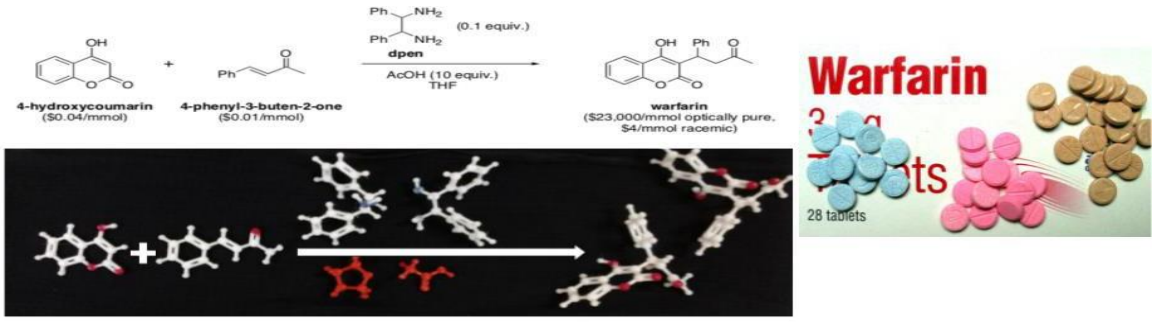

Figure 1. Chemical reaction pertaining to warfarin synthesis and 3D printed molecular models

Solving the problem required students to work with various tools such as 3D printed molecular models, model construction kits, and a molecular visualization application. Students also had to employ major forms of representational reasoning like analogical reasoning and/or thought experimentation with representations (refer to *Figure 2*). Students had to interpret complex symbolic representations of chemical reaction steps, determine the spatial arrangement of the intermediate structure formed based on their choice of catalyst and then finally predict the expected drug's spatial arrangement by applying stereochemistry concepts. Here the expected drug's spatial arrangement is most crucial as its therapeutic effectiveness is tied to it. The nature and complexity of the problem meant that students would experience numerous challenges nudging them to go beyond just verbal exchange and use or build the molecular models and sketch multi-perspective diagrams as part of their feedback-seeking dialogue. Thus the given problem helped us generate rich analyzable data where we could examine how students' feedback-seeking actions helped harness as well adapt to the competence distributed across peers, tools, and other activities.

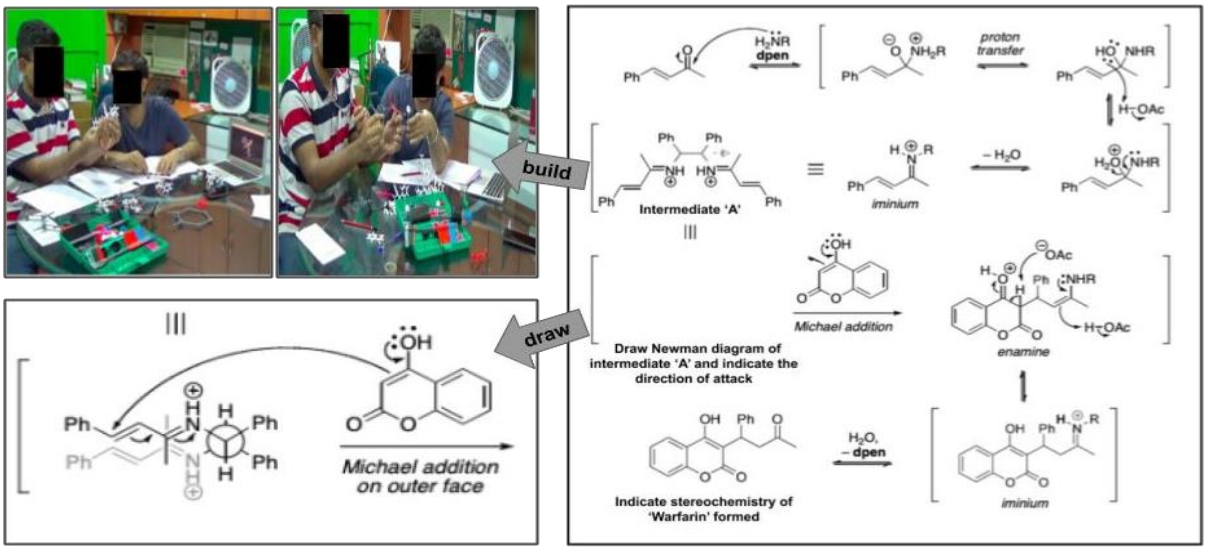

Figure 2. Reaction mechanism of warfarin synthesis adapted from Wong, Sultana, & Vosburg, 2010.

We adopted the case-study approach as it helps us answer our explanatory research question by providing rich and insightful descriptions (Yin, 2009). It affords going beyond exploration and diving

into the context-sensitive description of why things happened the way they happened. For data collection, we identified two groups of chemistry students using convenience sampling within our institute. One group had two male students and another had three male students. A prerequisite for selection was that they should have completed an introductory undergraduate stereochemistry course. The study was conducted with each group separately in a lab setting. In a post-activity interview, both groups reported that they had not come across any similar problems in their regular courses.

The given problem was an hour-long activity designed such that students could either work individually or choose to collaborate as and when needed. This was to ensure that there was no external compulsion to seek or provide feedback. The same was explicitly mentioned in the worksheets of instruction given to them. Besides, worksheets were minimal in design i.e., we intentionally did not include any prompts for self/peer assessment, hints, or questions for reflection. Worksheets given to each student had the following details and tasks in sequence. The first page included information on stereo chemicals as medicinal drugs in general and warfarin in particular, then on the need for selective synthesis of such medicines, the importance of underlying concepts and skills for their future careers, also task-specific expected goals and definitions, and a list of available tools along with the expected nature of their participation. The second and third pages were on identifying, naming, and translating 3D models of warfarin and dpen organocatalyst into 2D diagrams as per chemical conventions. The fourth and last page of the worksheet had a laboratory procedure underlying warfarin synthesis and its reaction mechanism with a missing step that students had to figure out.

Data collected as part of the study included video recordings of the students' interactions with each other and the researcher and their task-specific responses on worksheets such as sketches, highlights, and comments. The video was recorded using a single camera placed at a sufficient distance away from the round table where participants were seated. Participants could move around the table freely to assist each other if needed. The researcher's presence during students' problem solving was kept limited and occasional. Data analysis was done using a microgenetic method. It emphasizes tracing the emergence of particular student actions to momentary processes by making high-density observations spanning the timescale of the event concerned (Chinn & Sherin, 2014). The choice of method aligns with the CHAT framework's need to temporally examine how feedback-seeking emerges, evolves, and ends. Another reason was the duration of feedback-seeking episodes which varied between a few seconds to minutes. Observations were not limited to actions of a student seeking feedback, they also included what others were doing.

To arrive at key inferences, we employed competitive argumentation with colleagues where sample data was collaboratively analyzed to rule out possible alternate explanations. However, there were differences amongst us with respect to the emotions identified. So we reflected upon the sources of differences and found that they were mainly arising due to differences in our noticing of particular behavioral aspects and attribution. For example, some were attending to a student's facial expression while others were attending to their body posture. So we put together a list of parameters tied to emotions from literature such as behavior considered i.e., specific verbal and nonverbal aspects, the intensity of the emotion, the time dimension of emotion i.e., whether it was elicited in retrospective e.g. relief, or as prospective e.g. anxiety. These parameters helped us resolve differences.

The unit of analysis is an episode of students' proactive feedback-seeking where all decisions tied to it should have been made by the students themselves. One episode is distinguished from another by considering the change in the purpose for which the feedback is sought. We used empirical referents such as verbal questions addressing peers, moving closer to the feedback source while thinking aloud, pointing at and moving the artifact closer to the source while explaining, and drawing the attention of the source by tapping a pencil or raising a voice for identifying an episode's starting point. Similarly, the episode's endpoint was signified by referents such as nodding head in approval, verbal acknowledgment, moving away from the source, source getting back to his/her task, or taking back artifacts. For identifying factors comprising instructional activity which influenced students' different feedback-seeking actions, we examined aspects tied to task, artifacts, student, and feedback sources by going back and forth a few seconds before and after the episode.

3. Findings

3.1 Role of Feedback-Seeking Actions in Harnessing Distributed Competence

Throughout the instructional activity, students proactively sought feedback from each other for diverse purposes and engaged in varying amounts of dialogue depending on the characteristics of tasks and peers. They also used multiple languages and modes for feedback-seeking and subjected the feedback received to considerable evaluation. Particularly, in line with the notion of distributed competence, it was observed that even within a single task the role of feedback-seeker and feedback-provider kept shifting among the group members. For instance, consider the following observations from a 3 member student group while they were working on determining 3D warfarin molecules' stereochemistry and sketching their 2D diagrams as per the required chemical convention.

After a few moments into the above task, student S1 (redshirt in *Figure. 3*) was observed holding and comparing the models of two warfarin molecules in one hand and sketching their abbreviated forms in another hand. Besides, while sketching S1 was also thinking aloud "R1..R2..R3…so…1, 2, 3 and hence S". Here, by R1, R2, R3 student is referring to different parts of the molecule and then by 1, 2, 3 he is assigning a certain priority to those parts. 'S' indicates the stereochemistry of warfarin. Immediately after uttering those words, S1 taps on student S2's (yellow shirt in *Figure. 3*) arm and invites his attention. As S2 pays attention, S1 repeats his thinking while pointing at different parts of the molecule and asks "Is this fine?". S2 responds by giving confirmation. Later, S1 continues to seek feedback from S2 intermittently for different purposes i.e., once to confirm whether a particular atom in the molecule is oxygen and at another instance, he invites comments on his sketches of warfarin molecules. In relation to the same task a few moments later, S2 was observed to seek feedback from S1 for ensuring procedural accuracy needed to assign group priority within warfarin and S3 sought feedback from S2 on his 2D sketches.

Figure 3. Student S1 (red shirt) seeking feedback from student S2 (Yellow Shirt).

The above observations suggest that although S1 was able to recall the needed knowledge and procedures from his prior learning, he was still very unsure about it. For S2 to be in a position to confirm S1, he should have been able to successfully recall and be certain about it. Therefore, S1 here is harnessing S2's competence of being able to successfully recall the specific knowledge and procedure with a certain confidence that was needed at the moment. Next, when we investigated how S2 came to be in a position to confirm S1's other feedback-seeking instance i.e., on confirming whether a particular atom of warfarin was oxygen, we found that during the initial orientation each student had attended to different aspects of the information told by the researcher. Each student also asked different questions to the researcher regarding specific molecular models and their particular features. S2 had then raised questions on the warfarin model and its specific features including oxygen to which the researcher had responded. Consequently, it put him in a position to confidently confirm S1's question on oxygen. A similar observation was also made in the subsequent task where S1 acted as a feedback source to S3's question on catalyst molecules. This was again mapped back to S1's initial question on catalysts to the researcher during orientation. Thus it could be said that during orientation participants' attentional resources were distributed and later while working on the given tasks they were harnessing their results from each other. Then regarding S1's invitation to S2 and S3's invitation to S2 for checking their sketches, it could be said that it helped them both harness S2's monitoring capabilities. Additionally, S2's feedback-seeking from S1 by revealing his reasoning and eliciting S1's reasoning as a response

helped S2 rectify a crucial error in the priority assignment. Overall, the above feedback-seeking actions helped students to harness the distributed nature of each other's attention, memory, reasoning, and monitoring resources.

Similar to the distributed nature of competence amongst individual students, the competence needed to accomplish a task can also be distributed across multiple artifacts either provided by the instructor or those created by the students. Therefore, harnessing competence distributed across relevant artifacts becomes as crucial as harnessing competence distributed across individuals. Consider the following interactions from a 2 member undergraduate student group depicted in *Figure 4* below. The depiction lists the sequence of artifacts i.e., different molecular models and sketches referred by student S1 (feedback-seeker) and student S2 (feedback-provider) before and during feedback-seeking. These interactions emerged when both students were trying to make sense of the reaction mechanism behind warfarin synthesis.

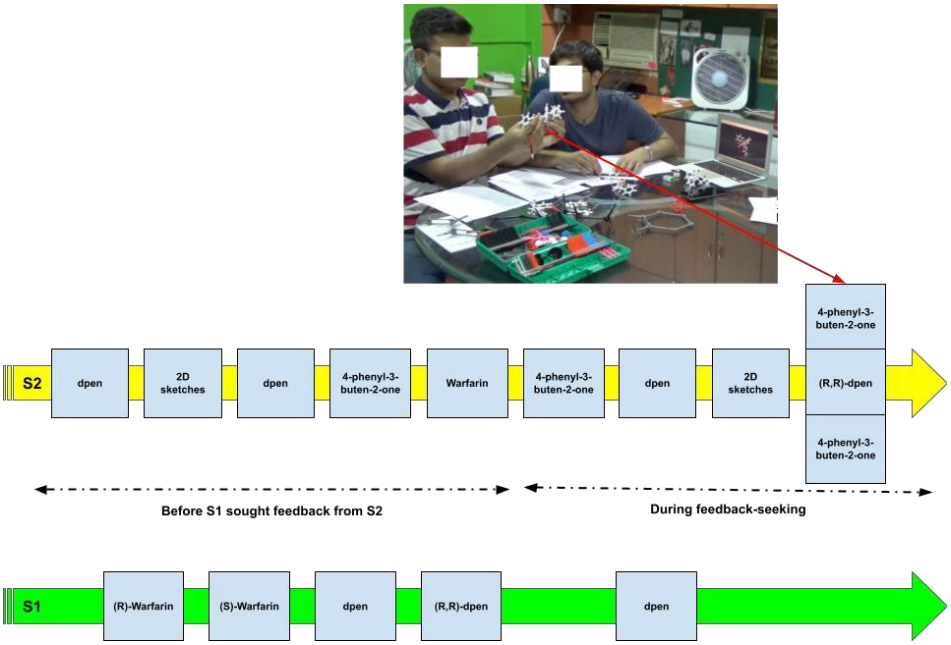

Figure 4. The sequence of artifacts referred by students S1 (blue shirt) and S2 (striped shirt).

The above depiction shows that by the time S1 sought feedback, S2 had already referred to different individual molecular models i.e., dpen and phenyl-buten-one which he would later use to build an intermediate structure required to answer S1's question on catalyst: What does the dpen do? and where does it attack? In comparison to S2, S1 was observed trying to make sense of the reaction mechanism by referring to just one model i.e., dpen tied to the intermediate structure. In the reaction mechanism, the intermediate structure was formed by two molecules of 4-phenyl-3-buten-2-one and one molecule of 'dpen' catalyst with a unique spatial arrangement. In the above depiction, letters (R) or (R, R) and (S) or (S, S) before individual molecular model names refer to the spatial arrangement or stereochemistry of atoms and groups of atoms within that molecule. Importantly, we also observed that just before feedback-seeking S1 was experiencing discomfort or difficulty as indicated by his facial expression and gestures, whereas S2 was observed uttering a few self-directed words followed by humming a tune of some song. S2's utterances and humming tune probably signaled feedback availability to S1. These observations suggest that the emergence of the feedback-availability state in S2 and the feedback-non availability state in S1 can be attributed to the nature in which students were harnessing the competence or the relevant information and affordances distributed or encoded across multiple models. Thus feedback-seeking at the self-level involving interactions with artifacts can be as crucial as feedback-seeking at an interpersonal level for harnessing distributed competence. This feedback-seeking episode was followed by a state of feedback non-availability amongst both participants for a few minutes. This was in relation to making sense of the subsequent part of the reaction mechanism. During this feedback non-availability state, S1 tried to sketch the missing reaction step whereas S2 spent time reflecting on possibilities in the next reaction step. However, the act of sketching led to the emergence of feedback availability in S1, and consequently, S2 was observed seeking

feedback from S1. Here again, S1 can be said to have harnessed the competence that emerged with the artifact he produced i.e, the sketch of the missing reaction step.

3.2 Role of Feedback-Seeking Actions in Adapting to the Distributed Competence

Within an episode of feedback-seeking dialogue, although one student largely assumes the role of feedback-seeker and other/s as feedback-provider/s, it was observed that the feedback-seeker at times points to errors or adds to the missing information in the feedback received or even verifies it by consulting alternate sources. Also, the student seeking feedback was observed to help the feedback-provider by doing certain work like sketching or finding a particular molecular model needed to generate the feedback. So feedback-seeking is not a simple one-way reception of answers from feedback providers. Instead, it involves both feedback-seeker and provider supplementing or at times complementing each other's competence i.e., adapting to the distributed competence amongst them. Table 1 presents a few excerpts from a feedback-seeking episode in support of our argument.

Table 1. Excerpts from a Feedback-Seeking Episode Reflecting Adaption to Distributed Competence

Sl. No	Excerpts
1	Feedback-seeker (S1) pointing to error in feedback received from S2 **S1**: attacking on what? **S2**: this one (pointing pencil alternately at reaction mechanism and model) so dpen will attack here on carbonyl directly.. carbonyl addition **S1**: where ..dpen? **S2**: this is dpen in my hand (turns the model in hand towards S1) **S1**: No dpen is this one (pointing at another model) **S2**: Haan (yes) sorry
2	Feedback-seeker (S1) adding to the missing information in feedback received from S2 **S2**: See this is intermediate..the attack is happening on this carbon **S1**: Intermediate? add the other one too. Looks for the missing molecular model in intermediate structure and gives to the S2
3	Feedback-seeker (S1) trying to verify the feedback provided by S2 with alternate source **S2**: Attack has to happen on this carbon from behind…pointing at the intermediate structure that he put together **S1**: Why will it attack from behind? **S1**: Moving the laptop in which the molecular visualization application was open..asks the researcher "Can we see the intermediate in this?"

In addition to the above instances, we also observed that students were revising their mode of feedback-provision and feedback-seeking within an episode to get their message across. For example in one episode, initially, the mode of feedback-seeking and the mode of feedback-provision involved just the verbal exchange but then the student seeking feedback remained unconvinced with the feedback received. So he kept probing the feedback-provider verbally. As a result, the peer providing feedback adapts one's mode of feedback-provision. He first uses the model to convey one's feedback and later sketches the 2D diagram to convey the same, recognizing that the former did not serve the purpose. In response, the student seeking feedback still unconvinced builds a model to convey one's reason and goes on to elicit more feedback. Importantly, these transitions were fraught with emotions such as irritation and frustration. Here students were trying multiple modes of feedback-seeking and provision unsuccessfully. Such unsuccessful attempts nudged them to adapt to each other's competence by complementing their mode of feedback-seeking and provision.

Other than adapting to distributed competence at the interpersonal level, students also learn to harness and adapt to the competence incorporated within particular tools. This is because tools like the model construction kit provided to students to an extent constraint student actions in a desirable

direction and help reduce errors in their prediction. However, a student in a 3 member group tries using the model construction kit for a while and then gives up saying that it's too complicated. Later in the post-activity interview, he reveals that particular software that translates 2D chemical structural diagrams to 3D molecular would have been much easier for the same task. So letting students consider and even try alternate tools during instructional activity can help them better harness and adapt to the competence distributed across multiple tools.

3.3 Barriers to Harnessing and Adapting to the Distributed Competence

Both the nature of student interactions during instructional activity and their post-activity interview responses made us aware of various barriers which students might experience in harnessing and adapting to distributed competence through feedback-seeking. These barriers included issues such as the language of communication, group composition, and size, nature of cooperation, access to alternate tools, opportunity to consult non-group members, and also the presence of an instructor.

For instance, consider the following interactions of a two-member student group which occurred after almost 7 minutes into the instructional activity. At this particular moment, S2 pointing at specifics of a molecular model and then looking at S1 asks him in Hindi (a native language) “this one here is tetrahedral center right?”. Until then the conversations were in English only. In response to S2’s question, S1 first looks at where S2 is pointing and then instead of answering him looks at the researcher and asks hesitantly “can we talk in Hindi right? Can we talk in Hindi? it’s….” Researcher responds “okay, yeah yeah” before S1 completes his sentence. But then a moment later asks them about their difficulty in speaking English. For which S2 responds by saying “no.. he is” suggesting that it is S1 who has the difficulty and S1 confirms by saying with an embarrassed smile “I am comfortable in Hindi so”. Finally, when the researcher tells them to speak in whichever language they are comfortable with, S1 responds with a relieved smile that he will go with Hindi.

In the above interactions, S1’s timing of the question on language and emotions reflects his heightened sensitivity towards the choice of language that he can or cannot use in instructional settings. Origins of such heightened sensitivity can be traced to the popular practices in educational institutions here where the use of native languages is often restricted and any non-adherence is treated with humiliation in order to push students to learn English as it is viewed as key to access better employment opportunities in future. However, compelling students to interact in a language that they are not comfortable with might significantly hinder their feedback-seeking and hence can act as a barrier to harnessing and adapting to the distributed competence. Similarly, in a 3 member group, students were observed to spontaneously shift between 3 different languages. Besides, in the post-activity interview, they also expressed that they wish to have the freedom to speak in any language of choice.

Closely related to the above language issue is the group composition. Students in the interview expressed that they would like to have the freedom to choose group members. In the context of this study, it translates into students being able to choose potential feedback sources. Underlying reasons included members not acknowledging the differences in language backgrounds i.e., within a group, few members would keep conversing in a particular language that other members do not understand. Besides, reasons also included issues tied to cooperation arising due to differences in motivation i.e, not all members will be ready to invest the time and effort equitably. As reported by one student, the difference in motivation itself arises because different student groups in the classroom are aiming for different future prospects with respect to academics and careers. So some might be more interested in particular topics than others. Additionally, one student expressed the need for having more members in the group in comparison to the current group size. Therefore, negotiating these issues will be crucial for facilitating students to harness and adapt to distributed competence.

Regarding the researcher’s questions on whether they should have been provided with the opportunity to consult non-group members, students expressed that such an opportunity would have been very helpful. Moreover, they revealed that they would have approached a few seniors working in an organic synthesis lab as they would have better knowledge about the topics such as the one given to them. Then with regard to questions on the presence of a researcher or teacher, all students expressed in agreement that the limited or occasional presence of the teacher or researcher is sufficient. They said that it helped them discuss with each other much more freely than if the researcher or teacher were to be present throughout the activity. Also, as previously discussed students expressed that they should be free to access and try alternate tools during the instructional activities.

Finally, whether a student perceives the given activity as a learning event or a testing event may have significant implications for feedback interactions within a group. For instance, we observed in one group that a student who perceived the instructional activity as a testing event was reluctant in providing feedback initially. He even expressed irritation when other members started discussing. This occurred due to the norm of instructional activity which stated that students can either choose to work individually or collaboratively. Hence this student perceived that the given activity might be a testing event. However, this observation does indicate that the current trend of merging learning events with testing events focused on evaluating individual competence might act as a hindrance to feedback interactions amongst students.

4. Discussion and Conclusion

This study provides preliminary evidence on the role of students' feedback-seeking in harnessing and adapting to the competence distributed across peers and tools in a particular instructional activity of significance. Findings included observations made at the intersection of student-student interactions and student-tool interactions. These observations helped reveal that distributed competence is the natural outcome of distributed nature of students' attention, memory, reasoning, and regulation. Similarly, observations also reveal that the competence needed to accomplish a task can be distributed across multiple tools and student-generated artifacts. This is again because tools are materials designed to embody certain human actions to constrain user actions and thinking in desirable directions. Findings also show that students' feedback-seeking is not a simple one-way reception of answers but it is dialogic and involves both feedback-seeker and provider supplementing or at times complementing each other's competence. Such dialogic interactions help nurture adaptation to the distributed competence. Besides, the findings highlight that feedback-seeking at the self-level or trying to generate the needed feedback by thinking or working with tools individually could be as important as feedback-seeking at an interpersonal level. Hence giving students the freedom to regulate shifting between feedback-seeking at the self-level and interpersonal level might be desirable.

Overall, when the above findings are considered together, it tells us that multiple factors such as tools, representations, norms, community, and the nature of cooperation within the immediate instructional activity as well as larger culture influences students' feedback-seeking actions. More importantly, these findings would not have been possible without addressing the gaps in the key interconnected notions such as instructional activity, feedback, students' feedback-seeking actions, and competence. Reconceptualization of these notions as per cultural-historical activity theory helped us with the much-needed perspective to observe and make sense of the student interactions. Also, note that the reconceptualization of these notions holds for both classroom instruction and CSCL environments. However, more research is needed to establish the role of feedback-seeking actions in not just harnessing or adapting but also for further nurturing distributed competence amongst students in actual classroom settings. This can potentially help inform student-agency-oriented sustainable alternatives to the prevailing largely teacher-driven approaches to feedback provision and students' competency development. In this regard, findings that particularly hold interesting insights for future research is that students' feedback-seeking can also occur due to dynamically emerging feedback availability cues amongst others working nearby. Also, recall students' intention to seek feedback from seniors during the interview. That is, if student groups of different academic years were working in a single classroom on activities of varying complexity and overlapping learning goals as shown in *Figure 5* below, then their various actions might help signal and elicit each other's feedback-seeking on much more diverse purposes. Similar affordances can also be built into CSCL environments connecting activities and students of different academic years or proficiencies. Here note that the current age-segregated classrooms were primarily informed by cognitive perspectives which viewed biological maturation as a precondition for learning. However, sociocultural approaches emphasize the developmental significance of being surrounded by activities far beyond one's capabilities along with the opportunities for naive participation in them (Rogoff et al., 2005).

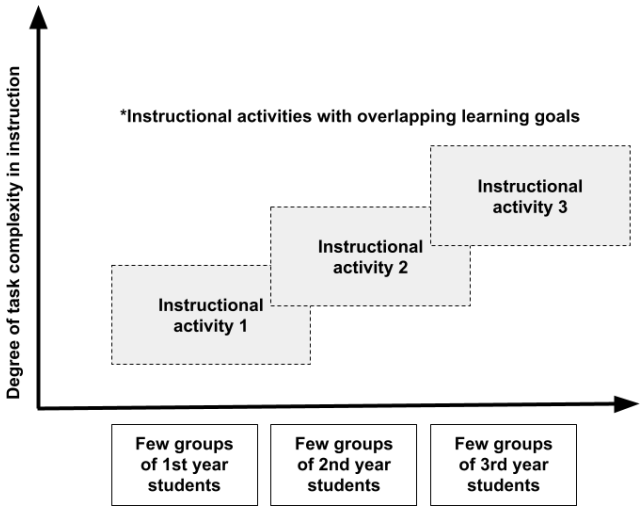

Figure 5. Classroom design for sustainably facilitating students' feedback-seeking actions

In classroom designs such as above, students can draw feedback from multiple sources and also through multiple modes. That is students can derive feedback either by observing multiple others or having a dialogue with them for various purposes. Finally, another important direction for future research is to investigate further and systematically address various barriers to students' feedback-seeking along their cognitive, emotional, motivational, and identity dimensions.

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