

# Characterising Shared Epistemic Agency in a Knowledge Building Learning Environment

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**Abstract:** This study examined the role of Knowledge Building (KB), enriched with Virtual Reality (VR) technologies, in supporting students' understanding of scientific practices and ecosystem concepts. Students' shared epistemic agency were characterized to examine the different patterns of strategies that students deployed while engaging in knowledge building. Twenty students of a Hong Kong middle school engaged in progressive theory-building as they mimic scientists to investigate its decrease in animal population within a virtual world. *Knowledge Forum* (KF) served as the platform for collaborative knowledge building and collective discourse. Key findings of this study include 1) improvement in understanding of concepts on ecology; 2) characterising shared epistemic agency as progressive levels. The implications of engaging students with KB to promote shared epistemic agency are discussed.

## Epistemic agency in science education

*Next Generation Science Standards* (NGSS Lead States, 2013) was developed as a call to transform students to become doers of science and engage in scientific practices (Miller, Manz, Russ, Stroupe, & Berland, 2018). A knowledge building environment that supports implementation of NGSS is one in which students assume collective cognitive responsibilities to establish collective inquiry goals. Knowledge building, supported by *Knowledge Forum* (KF), is a model that examines how students work as scientific communities that align with the notion of scientific practice (Miller et al., 2018). In Knowledge Building, epistemic agency has been examined as students taking responsibility for their knowledge advancement; comparing their models with scientific ones and using contrast to spark growth (Chan & van Aalst, 2015; Scardamalia & Bereiter 2014; Scardamalia, 2002). Although epistemic agency as a principle has been examined in learning sciences studies (Damsa, Kirschner, Andriessen, Erkens, & Sins, 2010), the notion of shared epistemic agency in Knowledge Building needs to be examined further, emphasising collective responsibility. In this study, we consider shared epistemic agency as students' spontaneously deploying strategies that are conducive to community knowledge improvement while they are attending to divergent ideas. A major purpose of this study is to reveal the progressive strategies students deployed. While few studies provided insights of contextualizing Virtual Reality (VR) design in a collaborative knowledge building environment, this study will shed light on the integration of different technologies with KB which synergise to create a learning environment ideal for promoting students' understanding of ecosystem concepts and scientific practices. Research questions of this study are: 1. To what extent did the KB environment enriched with VR support students' understanding of ecosystem concepts and scientific practices? 2. How to characterise students' enactment of shared epistemic agency using students contributions on *Knowledge Forum*?

## Method

A mixed-gender class of 20 grade seven students from a Hong Kong middle school participated in this study. The 10-week curriculum where students actively collaborate to investigate the problem centred about the decrease in animal population in *Omosa Virtual World*. *Knowledge Forum*, *Omosa Virtual World* and *Omosa NetLogo* were used as tools to facilitate students' knowledge building process. The curriculum was designed in phases as follows: students articulating thoughts on KF, deepening discourse through KB talks and reflective assessment, improving ideas through experimenting and testing of hypotheses and rising above divergent ideas. In this study, students' understanding of ecosystem concepts and scientific practices were evaluated by their pre-posttest performance and scientific presentations. KF notes and portfolio notes were used to characterise students' shared epistemic agency. To write a portfolio note, students had to select relevant notes from KF and cite them to trace the progression of collective discourse. These notes reflect their knowledge building process and charts out how the community collectively contribute and synergise to reach its final state. Strategies that students employ to engage their divergent ideas will be identified to examine the development of shared epistemic agency in the community.

## Results

## Students' understanding of ecosystem concepts and scientific practices

Students' responses for the pre-posttest were coded based on a 4-level coding scheme to assess their change in understanding of ecosystem concepts. The t-test indicated a statistically significant increase in pre-posttest scores with  $t = 6.52$ ,  $p < .001$ ,  $d = 1.80$ . Students provided deeper reasonings in the post-test and created linkages between core ideas including interrelatedness of biodiversity, the stability of the ecosystem and the relationship between biodiversity and humans. During the scientific presentations, students shared their research study and showcased their data collection process, core ideas discussed on KF, findings from their test trials on *Omosa NetLogo* and conclusions on their research. Students' reflection showed that they understood the iterative nature of the scientific process and the necessity to validate their hypotheses with evidence. Moreover, it also exemplified students' attempts to coordinate multiple types of technological tools to adapt to the iterative process of scientific practices.

## Different levels of students' shared epistemic agency

*Knowledge Forum* portfolio notes, illustrating students' reflection on trajectory of community events, were analysed to examine their engagement with divergent ideas to advance community ideas. Such evidence is indicators of students' enactment of shared epistemic agency. Three levels of shared epistemic agency were identified as *novice*, *intermediate* and *advanced*. For the *Novice level*, students listed, copied and made summaries of KF notes. Students listed major reasons that might be plausible to solve the overarching problem without making any ideas extensions beyond listing and summarising. For the *Intermediate level*, students made references to ideas presented on KF and reflected upon how different ideas supported his personal idea development. The *Advanced level* was featured by students reflection on the ideas development trajectory of the whole community and discussed the extent to which such development shaped their idea improvement. The three levels were identified in the students' contributions and constitute a trajectory which represented students' deploying strategies to rise above divergent ideas and improve collective knowledge. Such developmental trajectory echo with the description of epistemic agency from Scardamalia (2002) in terms of how individuals negotiated ideas with the community while attending to divergent ideas to advance both individual and community knowledge.

## Discussion

Results of this study showed that this lesson design involving Knowledge Building pedagogy with the effective use of VR and KF was able to increase students' conceptual understanding and provide an environment to simulate how scientists worked to solve problems. In this study, we proposed a framework of characterising the level of shared epistemic agency. Through the examination of how students deal with divergent ideas, rise above of divergence and advance community ideas, this framework provide some ways to examine the emergence of shared epistemic agency among learners. The framework highlights the developmental process of shared epistemic agency, beginning with *Novice level* of listing and summarising of key ideas, then progressing to the *Intermediate level* which involves added considerations on knowledge as individual entities and moving towards the *Advance level* in which understanding of how ideas advanced in the community is evident and is related to individual's knowledge development. The distinction between *Intermediate level* and *Advance level* is critical to KB as it posits a strong emphasis on community knowledge advancement through shared epistemic agency.

## References

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