

Elementary Students' View of Collaborative Knowledge Building in Learning Villages

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Abstract: *Learning Villages* (LV) is an online game-based virtual learning environment. It aims at facilitating elementary students to pursue social inquiry learning and hence attain *collaborative knowledge building* (CKB). LV operates in the form of massively multi-player online role-play gaming. Different villages in this “virtual world” represent different societal issues. To embark on the development of a village, students have to inquire collaboratively into the issue therein. Besides delineating the pedagogical design of LV, this paper also discusses our quantitative study on investigating the CKB affordance of this educational innovation from the student perspective (involving 229 elementary students in Hong Kong). Results showed that LV brought desirable CKB experience to the students in general. On top of that, we found the students with low academic achievement held a more positive perception (i.e. the affordance of LV in facilitating CKB) than the students with high and moderate achievement did.

Keywords: Social inquiry learning, collaborative knowledge building, game-based learning, virtual learning environment

1 Introduction

Constructivist education [1, 2], which emphasizes knowledge should be constructed actively by learners rather than being received passively from teachers, has been promoted persuasively since the twenty-first century [3]. *Social inquiry learning* [4, 5, 6] is one of the constructivist learning approaches advocated in education today, where a learner can construct his/her own knowledge about humans and their interactions with the “societal” world [7, 8].

Upon the notion of social-constructivism [9], *collaboration* is regarded as an important empowering component in the course of social inquiry learning in which learners are working in groups to build their societal knowledge constructively [10]. This collective knowledge acquisition process is termed *collaborative knowledge building* (CKB) [11, 12]. In addition, learners' motivation is another key component in social inquiry learning. Not only does it help promote CKB, it is essential for deep learning [13, 14].

LearningVillages (LV) is an online game-based CKB platform that we have developed to support elementary students in pursuing social inquiry learning. The aims of this paper are two-fold: besides delineating the design of LV, we discuss our quantitative study on investigating the affordance of LV in supporting CKB in the course of social inquiry learning. The rest of the paper is organized as follows: Section 2 is a review of the related work. Section 3 elaborates LV's pedagogical design. Sections 4 and 5 will delineate respectively the research design and findings. We will discuss our future work in Section 6 and give our concluding remarks in Section 7.

2 Related Work

Inquiry learning emphasizes learning as the process of seeking knowledge, raising questions, searching for answers, evaluating information, and asking new questions based on new understandings [15]. *Scientific inquiry* and *social inquiry* are two common paradigms of this learning approach. The former has been adopted considerably in science education (e.g. [16, 17]). Usually, it requires learners to question, hypothesize and investigate the natural, physical world, accenting a search for precise and repeatable evidence in order to prove or disprove a hypothesis and draw conclusions about the "truth." The focus of our work is on the latter, social inquiry learning.

2.1 Social Inquiry Learning

Social inquiry learning has been adopted notably in social and humanities education (e.g. [4, 5, 6, 7, 8]). The course of inquiry usually pivots on an open-ended, argumentative societal issue. Instead of looking for "natural/physical" truths in the world, it emphasizes on learners' understanding and reflecting on humans and their interactions with the "societal" world from multiple perspectives, values and interests.

In the past decades, a number of pedagogical models were designed to guide students in pursuing social inquiry learning in K-12 education. For example, Kuhlthau [18] proposed a *step-wise* model consisting of seven steps: *Initiation, Selection, Exploration, Formulation, Collection, Presentation, and Assessment*. Newell [19] proposed a *task-wise* model consisting of seven tasks: *Task Identification, Search Strategy Initiation, Information Location, Information Evaluation, Information Use, Information Communication, and Problem-solving Product/Process Evaluation*. Similar step-by-step or task-by-task elements could also be found in other models such as *Big6* [20], *The Simple Four* [21], *Organized Investigator* [22] etc. However, Small et al. [13] argued that, most of the models emphasized largely on *information problem-solving* which focuses on "find(ing) the best information about a problem or issue in order to support a thesis and to reorganize that information into a product."

Educators like Jansen [8] and Chadwick [23] underlined that social inquiry learning should be a non-linear process, driven recursively by questioning, thoughtful investigation, making sense of information, and developing new understanding. Stripling [5, 6] furthered that the goal of social inquiry learning should not be the accumulation of information, but the exploration of significant questions and deep

learning. Inspired by notions of Dewey's [24] *learning through experience*, Vygotsky's [9] *zone of proximal development*, as well as Bruner's [1] *interpretation in learning*, Stripling developed a cyclical social inquiry learning model, namely *Stripling Model of Inquiry*, for K-12 education. The model consists of six inquiry phases: (i) *Connect*, (ii) *Wonder*, (iii) *Investigate*, (iv) *Construct*, (v) *Express*, and (vi) *Reflect* (as illustrated in Fig. 1 and described in Table 1). The phases, which take place in a recursive and overlapping manner, are featured with specific thinking strategies and inquiry actions to guide students through social inquiry learning to build societal knowledge on their own. Stripling's work is a theoretical basis for the pedagogical design of LV (see Section 3).

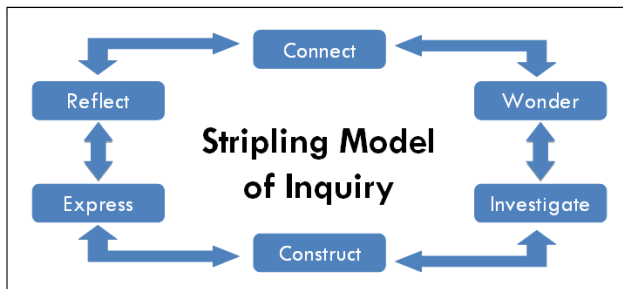


Fig. 1. Stripling Model of Inquiry

Table 1. Six Inquiry Phases of the Stripling Model of Inquiry

Phase	Description
i. Connect	<ul style="list-style-type: none"> • Connect to self, previous knowledge • Gain background and context
ii. Wonder	<ul style="list-style-type: none"> • Develop questions • Construct arguments
iii. Investigate	<ul style="list-style-type: none"> • Find and evaluate information to answer questions, assess arguments • Think about information to illuminate new questions and arguments
iv. Construct	<ul style="list-style-type: none"> • Construct new understandings connected to previous knowledge • Draw conclusions about questions and arguments
v. Express	<ul style="list-style-type: none"> • Apply understandings to new context, new situation • Express new ideas to share learning with others
vi. Reflect	<ul style="list-style-type: none"> • Reflect on own learning • Ask new questions

2.2 Collaborative Knowledge Building

Collaboration is an interactive and iterative process in which a group of individuals negotiate and share meanings to achieve a common goal; it involves the construction and maintenance of shared knowledge and task(s) to be accomplished [25]. Many contemporary instances of social inquiry learning (e.g. [3, 10, 23]) regard

“collaboration among students” as one of the most important components to “catalyze” knowledge building in the course of inquiry. This collective knowledge acquisition process is termed *collaborative knowledge building* (CKB) [11, 12, 14].

Investigating effective approaches to better facilitating students in groups in order to attain CKB in social inquiry learning has been a significant interest in the field, particularly from both socio-cognitive and technological aspects. Scardamalia’s [11] work has been one of the most important pieces, putting forward the concept of *socio-cognitive responsibility*¹ for the advancement of CKB in technology-supported environments. She developed 12 principles to characterize the socio-cognitive and technological dynamics which facilitates CKB: (i) *Community Knowledge, Collective Responsibility*, (ii) *Democratizing Knowledge*, (iii) *Idea Diversity*, (iv) *Epistemic Agency*, (v) *Knowledge Building Discourse*, (vi) *Improvable Ideas*, (vii) *Constructive Uses of Authoritative Sources*, (viii) *Rise Above*, (ix) *Real Ideas, Authentic Problems*, (x) *Embedded, Concurrent and Transformative Assessment*, (xi) *Symmetric Knowledge Advance*, and (xii) *Pervasive Knowledge Building*. The details of each principle are delineated clearly in her literature.

Scardamalia’s [11] work has attracted considerable research attention, in particular, employing the CKB principles as an instrumental lens in various CKB-related research. Chan et al. [15] developed a 12-item CKB questionnaire (one item for one CKB principle) which possesses good reliability and construct validity to assess the CKB affordance of technology-supported environments. The research instrument adopted in the present study was customized from Chan et al.’s work (see Sub-section 4.4).

2.3 Computer-supported Collaborative Learning Environments

Although social inquiry learning can take place among a group of learners without using any technology in principle, Scardamalia [11] observed that technology can be very useful in the course of inquiry, not just because of overcoming the objective obstacles in conventional classroom conditions. More importantly, it facilitates the CKB process so that the knowledge advancement (i) “is in the social fabric of the organization,” (ii) “is enhanced through primacy given to creative work with ideas,” and (iii) “represents sustained work at the frontiers of understanding” [14].

The technological platforms adopted for facilitating CKB are commonly termed *computer-supported collaborative learning* environments [12, 14, 25]. They usually operate in the form of online multi-user asynchronous discussion forums, providing students with a shared working place to pursue progressive discourse interactions with their group members in the course of social inquiry learning. Nonetheless, there has been criticism (e.g. [26, 27, 28]) that this kind of learning environments are less effective to support learners, especially students at the elementary levels, to attain CKB successfully. The integration of *scaffolds* [29] into the environments framed with appropriate pedagogical models is critically vital. Moreover, learners’ engagement (i.e. participation and continued contribution) therein “can never be taken for granted” [30].

¹ Students take responsibility for knowing what needs to be known and for insuring that others know what needs to be known.

The ability of the environments to promote and sustain students' motivation is also notably important [13, 31].

2.4 Online Game-based Learning

Piaget [2] realized that curiosity is the best driving force for any kinds of learning; keeping learners curious by engaging them in game-like activities is the best approach to education. Upon the advancement of multimedia and web technologies these decades, online games have attracted a lot of game-based learning researchers' attention [32].

Gee [33] argued that many best-selling online creational games are already state-of-the-art learning games. In fact, harnessing popular creational games in the commercial market, massively multi-player online role-play games (MMORPGs) in particular, to stimulate students' learning motivation and foster the establishment of learning communities has been one of the recently important initiatives in the field. Representative work includes Squire's [34] adoption of *Civilization*, Kemp et al.'s [35] adoption of *Second Life*, and Rankin et al.'s [36] adoption of *EverQuest* to engage secondary and tertiary students in socio-networked contexts to pursue various learning activities. Nevertheless, in Hong Kong for example, teachers and parents' acceptance of using commercial MMORPGs in elementary education is quite low [32]. Adults are afraid that kids in those games may be easily exposed to inappropriate contents (such as violence, pornography and phishing information), or subjected to cyberbullying [37].

3 LearningVillages

The fundamental idea of LearningVillages (LV) is to situate students in an MMORPG environment to pursue so called "two-tier" (*village-level* and *house-level*) discourse interaction in the course of social inquiry learning. A *village* in LV represents a societal issue. Students in each village can build *houses* to denote their viewpoints or arguments with respect to the issue. They can further construct *roads* to interconnect the houses to reflect their in-between relationships. This is the *village-level discourse interaction*. Moreover, every house is "enterable," functioning as an independent forum to facilitate in-depth discussion about the corresponding viewpoint or argument. This is the *house-level discourse interaction*. The discussion threads inside the houses are termed *postings*. The more postings there are in a house, the larger its size and the more its modernity will be. The key strength of the two-tier design in LV is that, major viewpoints and arguments upon a societal issue and their mutual relationships can always appear neatly in the form of a mind map.

In our previous evaluative studies [38, 39] on the first version (the prototype) of LV, we obtained a very positive result in terms of motivating elementary students to participate in social inquiry learning. However, the quality of CKB in the villages was not satisfactory. We concluded in the studies that, appropriate social-inquiry scaffolds should be further integrated into LV in order to better support students to attain CKB.

The new version of LV retains the MMORPG features in the prior version. Each student can design his/her own virtual character in this "virtual world" (see Fig. 2).

There are various entertaining elements in LV, for example, playing various mini-games (see Fig. 3), meeting one another at various hangout places (see Fig. 4), having real-time chats, making funny gestures to draw others' attention etc. The most important advancement of the new version of LV over the prior one is the integration of the Stripling Model of Inquiry [7, 8] into the two-tier discourse interaction, framing the course of social inquiry learning into four operable inquiry stages. New types of houses and posting tags carrying with specific functions are implemented into the environment so as to support the redesigned village-level and house-level discourse interactions.



Fig. 2. Customization of a Student's Virtual Character



Fig. 3. LV's Mini-game Arcade



Fig. 4. Hangout in LV

Before letting a class of students pursue social inquiry learning in LV, the facilitator (usually the teacher of the students) has to determine a societal issue and the number of stakeholder roles (normally 4 to 5) with respect to the issue (see Fig. 11 in Sub-section 4.3 for an example). Apart from that, the facilitator will divide the class into groups. Normally, every group will be composed of 4 to 5 students, depending on the number of stakeholder roles. A village will be created for each group and every member (namely, *villager*) therein will be assigned with a different stakeholder role. After that, they will experience four inquiry stages which scaffold them to inquire into the issue and pursue CKB.

3.1 Inquiry Stage I

The *Connect*, *Wonder*, and *Reflect* phases of the Stripling Model shape the students' work at this stage. Fig. 5 shows the initial appearance of a village. At the beginning, each villager (hereinafter referred as "stakeholder") is required to visit the *Public Resource Centre* (PRC) and their own *Conference Base* (CB). The PRC contains "general" resources (usually in the form of web links and/or Internet videos) providing all stakeholders with the background information about the issue. Different from the PRC, each BC contains "specific" initial resources² dedicated only to one particular stakeholder, scaffolding him to gain some preliminary understanding of the assigned stakeholder role. For example, if there are k stakeholders, there will be k CBs. At this stage, each stakeholder can only enter his own BC, i.e. Stakeholder 1 cannot visit Stakeholder 2's CB. Apart from accessing the provided initial resources, each stakeholder is encouraged to look for new resources related to his role from the Internet, and document them by posting in his own CB. By the end of this stage, each stakeholder needs to complete two tasks. The first task is that, he has to build a *House of Argument*

² The resources are also in the form of web links and/or Internet videos.

(HoA) to denote his initial argument based on his preliminary knowledge of the issue (see Fig. 6). Inside the HoA, he will further create postings and then tag them (with “Description,” “Explanation,” and “Evidence,” see Fig. 7) to describe and explain the argument, as well as providing grounds for supporting it. Similar to the CBs, each stakeholder can only enter his own HoA at this stage. The second task is that, every stakeholder has to enter his private *Reflection Hall* (RH) (see Fig. 6) to reflect on his learning at this stage by “answering” a reflective question “What have you learned so far, and what’s next?”

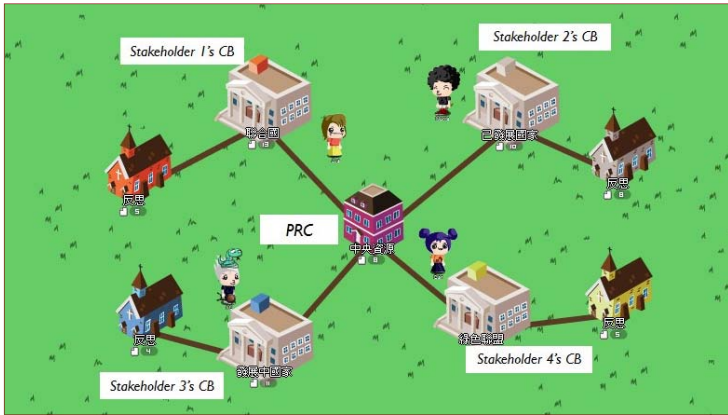


Fig. 5. Beginning of Inquiry Stage I

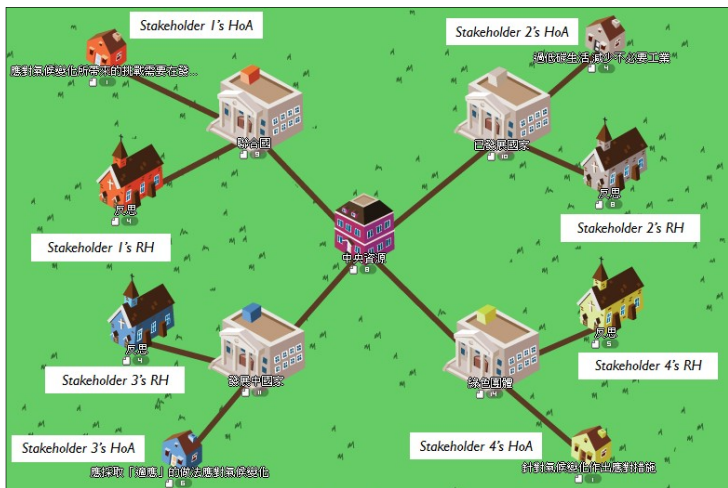


Fig. 6. Ending of Inquiry Stage I

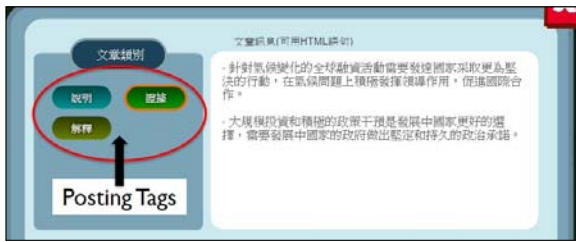


Fig. 7. Inside an House of Argument (HoA)

3.2 Inquiry Stage II

The *Wonder*, *Investigate*, and *Reflect* phases of the Stripling Model shape the students' work at this stage. All CBs and HoAs are now open for access. At the beginning, each stakeholder needs to gain better understanding about the other stakeholders' perspectives by visiting their CBs and HoAs in order to view their resources and their initial arguments. After that, he will look for counter-evidence from the Internet to challenge other stakeholders' arguments from his stakeholder role's perspective. By the end of this stage, each stakeholder is required to complete two further tasks. The first task is that, he has to build a *House of Bomb* (HoB) to denote his critique to each of the other stakeholders' initial arguments by connecting it to the corresponding HoA (see Fig. 8). For example, if there are k stakeholders, each stakeholder needs to create $k-1$ HoBs. Inside each HoB, he will further create postings to describe, explain and ground the "bomb" (critique). The second task is that, every stakeholder has to again enter his private RH to reflect on his learning at this stage by posting "answer" to the same reflective question as at Inquiry Stage I.

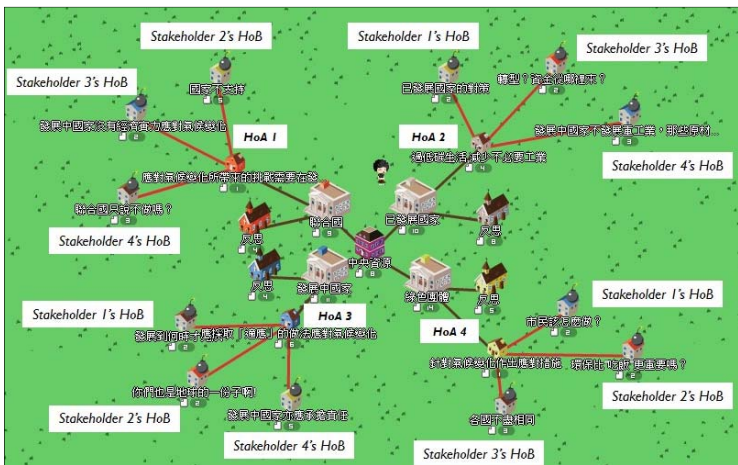


Fig. 8. Ending of Inquiry Stage II

3.3 Inquiry Stage III

The *Investigate*, *Construct*, and *Reflect* phases of the Stripling Model shape the students' work at this stage. At the beginning, each stakeholder will enter the HoBs "bombarding" his own HoA to read the critiques raised by other stakeholders on his initial argument made at Inquiry Stage I. After that, he has to probe further into the issue and look for additional resources from the Internet, so as to evaluate and make responses to the critiques. He can also go on documenting these new resources by posting in his own CB. By the end of this stage, each stakeholder is required to complete two further tasks. The first task is that, he has to create postings and tag them (with "Description," "Explanation," and "Counter Evidence") in the HoBs concerned to respond to the critiques therein. After that, the "bombardiers" (the owners of the HoBs, i.e., other stakeholders) will be alerted to review these responses. If they are satisfied with the responses, they can click the "peace" buttons in the HoBs to "stop the fire" (see Fig. 9). Then, the bomb icons on top of the HoBs will disappear. On the contrary, if they find the responses unsatisfactory, they can post their comments with the "Rebuttal" tag in the HoBs concerned to request further responses from the corresponding stakeholders. The second task is, similar to the previous stages, every stakeholder also has to again enter his private RH to reflect on his learning at this stage by "answering" the same reflective question.



Fig. 9. "Stop the Fire" at Stage III

3.4 Inquiry Stage IV

The *Construct*, *Express*, and *Reflect* phases of the Stripling Model shape the students' work at this stage. Balancing others' viewpoints, each stakeholder engages in revising and improving his initial argument posted in his own HoA. If necessary, he can look up the resources documented in the PRC and CBs again, and the reflection pieces posted in his own RH to refresh his understanding of the issue. He can also look up all prior

arguments, critiques, rebuttals, grounds, etc. posted previously in all HoAs and HoBs in the village. By the end of this stage, each stakeholder is required to complete two final tasks. The first task is that, he has to build a *House of Conclusion* (HoC) to denote his conclusive stance on the issue (see Fig. 10). He will express his “finalized” (i.e. revised, improved, and objectified) argument by posting inside his own HoC, accessible to other stakeholders. If necessary, the LV facilitator can also provide feedback for each stakeholder by posting with the “Comment” tag in each HoC. The second task is that, every stakeholder has to enter his private RH again to reflect on his learning in a summative manner by “answering” another reflective question “What have you learned in the whole inquiry activity?”

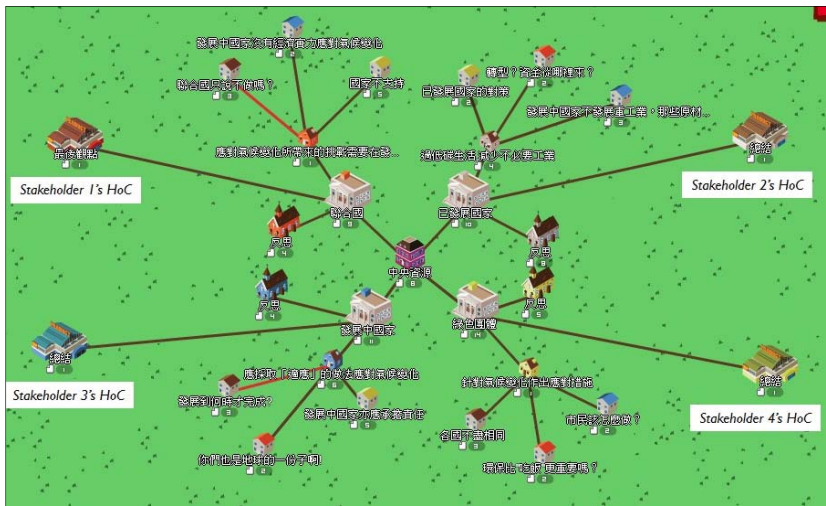


Fig.10. Ending of Inquiry Stage IV

4 Method

4.1 Subjects

Eight of our partner elementary schools were involved. They were all middle-banding schools in Hong Kong. From each school, we selected 30 Grade-5 student subjects (15 males and 15 females) to participate in this study, with a combination of 10 students with high academic achievement, 10 with moderate academic achievement, and 10 with low academic achievement. The total number of the student subjects were 240, aged 10.21 in average.

4.2 Societal Issue

The determination of the societal issue adopted in the study was based on two criteria: (i) the issue was related to the Grade-5 General Studies curriculum³ in Hong Kong, and (ii) the knowledge related to the issue had not been taught to the students previously at school. After having a meeting with eight General Studies teachers respectively from the eight schools, all of us agreed to select an issue related to the curricular module of *Conservation and Sustainable Development*, “Should the government set up a new measure to further reduce the use of plastic shopping bags in Hong Kong?” After that, we determined the four key stakeholders (*citizens, retailers, plastic bag suppliers, and environmental protection groups*), and prepared the corresponding resources to be put inside the PRC and CBs of every village. We also invited a General Studies educator at our University and a government curriculum officer to review the issue and the corresponding resources. Some minor modifications (mainly the wordings used in the resources) were made in accordance with their comments.

4.3 Manipulation

The social inquiry learning activity took place within the students’ 2-week term break. It involved 12 consecutive days to complete the four inquiry stages in LV (as described in Section 3), and each stage lasted for three days⁴. The students were asked to spend around 5 hours on finishing the specific tasks required at each stage at home or anywhere with Internet access, without seeking any help from neither their parent(s) nor other family member(s).

We randomly divided the eight schools into two clusters (i.e. four schools per cluster). The 120 students in each cluster were further divided into 30 inter-school groups (i.e. four students per group), each of which comprises four members from four different schools (as illustrated in Fig. 11). This setting aimed at controlling that the students in each group had not been familiar with one another before participating in this study. In general, we assigned the students from each school to different groups randomly, but kept an equal number of males and females in each group (i.e. 2 males and 2 females).

³ General Studies is a core subject in elementary education in Hong Kong. Social issue inquiry is one of the important pedagogical approaches to carrying out the learning and teaching activities in this subject.

⁴ Stage 1: Days 1 to 3; Stage 2: Days 4 to 6; Stage 3: Days 7 to 9; and Stage 4: Days 10 to 12.



Fig. 11. Setting of an inter-school group

There were totally 60 inter-school groups in the two clusters. Every group had their own village in LV. In each group, every member was pre-assigned to one of the four stakeholders of the issue in a random manner (see Fig. 11). For the present research purpose, we restricted technically at the server backend that every group could only have access to their own village, not other groups' villages. Three days before the start of the learning activity, we conducted a 45-minute briefing session at each school to introduce LV and the activity to the students, distributing the LV user accounts to them, and letting them have "trial-play"⁵ on LV.

4.4 Data Collection

We adopted a quantitative approach (with a questionnaire-based survey) to achieving the aim of the present study. Right after the term break, we conducted the survey respectively at each school in the first 15 minutes of the first lesson on the first day. The questionnaire was in Chinese (i.e. the mother language of the students), containing 12 CKB (CKB) items customized from Chan et al.'s [12] theoretically-guided one-factor CKB questionnaire (see Sub-section 2.3). The students were asked to rate each item along a 5-point scale from "1" (strongly disagree) to "5" (strongly agree) according to their own social inquiry learning experience in LV. In order to ensure every item would be understandable to the students, we invited the eight General Studies teachers from the eight schools to review the questionnaire. Based on their

⁵ The 60 villages had yet to be accessible until the first day of the learning activity.

feedback, we made some minor revisions on wordings of the four items. Table 3 in Section 5 displays a translated version of the questionnaire.

5 Findings and Discussion

We received totally 229 questionnaires (return rate: 95.4%). Table 2 displays the 229 students' demographic information in groups, in terms of gender and academic achievement.

Table 2. Students' Demographic Information in Groups

(i) Gender N = 229		(ii) Academic Achievement N = 229		
Male	Female	Low	Moderate	High
111	118	75	78	76

5.1 Reliability and Validity

The Cronbach alpha of the 12 CKB items was .89, indicating adequate reliability of the collected data. Table 3 shows the result of the confirmatory factor analysis (FL: factor loading). The confirmative factor analysis generated the following goodness of fit indices: CFI = .97, GFI = .96, RMR = .03, and SRMR = .03, indicating a satisfactory model fit. Hence, both reliability and validity were comparably good as the ones in Chan et al.'s [12] work.

Table 3. Factor Loadings and Univariate Descriptive Statistics of the CKB Items

	Item	FL	M	SD
1. Community Knowledge, Collective Responsibility	Our views and knowledge broaden through working with others in LV.	.61	4.22	.85
2. Democratizing Knowledge	Ideas from different members are equally valuable in LV.	.59	4.12	.79
3. Idea Diversity	Members pose different ideas with diverse perspectives in LV.	.70	4.21	.82
4. Epistemic Agency	Goal setting and planning for our progress is important in LV.	.64	4.28	.80
5. Knowledge Building Discourse	Ideas are exchanged to improve our knowledge in LV.	.63	4.31	.77
6. Improvable Ideas	We work on improving our ideas continually during the process of inquiry in LV.	.71	4.35	.81

7. Constructive Uses of Authoritative Sources	Different sources of reference information are examined for building knowledge in LV.	.59	4.10	.75
8. Rise Above	Ideas from different members are synthesized into new knowledge in LV.	.58	4.10	.89
9. Real Ideas, Authentic Problems	The knowledge we work on is relevant to real-life problems in LV.	.57	4.15	.73
10. Embedded, Concurrent and Transformative Assessment	We reflect on and assess the progress of our understanding continually in LV	.61	4.13	.78
11. Symmetric Knowledge Advance	Different members can benefit each other and make progress together in LV	.61	4.38	.79
12. Pervasive Knowledge Building	Our ideas and knowledge are relevant within and outside the school context in LV.	.67	4.32	.77

5.2 Survey Results

Table 3 also displays the univariate descriptive statistics of the 12 CKB items (M: mean; SD: standard deviation). The items' means ranged from 4.10 to 4.38 (out of 5). The overall CKB mean (the average of the 12 items) was 4.22, revealing the students perceived that LV provided them with desirable CKB experience in the social inquiry learning process in general. Further, we were interested in looking into whether (i) different gender groups and (ii) different academic-achievement groups perceived LV's CKB affordance differently.

Tables 4 and 5 shows the univariate descriptive statistics of the overall CKB means with respect to the gender groups and the academic-achievement groups. An independent samples t-test indicated that there was no significant difference between two gender groups' means ($t(227) = .60, p > .05$). In other words, no evidence signified that the gender influenced the students' responses to the CKB items. On the other hand, a one-way ANOVA indicated there was a significant difference among the three academic-achievement groups' means ($F(2, 226) = 6.42, p < .01$). A post hoc Tukey HSD test revealed that the low academic-achievement group's mean was larger statistically than the high academic-achievement group's ($p < .01$) and the moderate academic-achievement group's ($p < .05$). There was no significant difference between the means of the high and moderate academic-achievement groups. The analyses signified that the students with low academic achievement held a more positive perception (i.e. the affordance of LV in facilitating CKB) than the high and moderate academic-achievement students did.

Table 4. Different Gender Groups' Overall CKB Means (N = 229)

Gender	N	CKB
Male	111	4.33
Female	118	4.12

Table 5. Different Academic-achievement Groups' Overall CKB means (N = 229)

Academic Achievement	N	CKB
High	76	4.09
Moderate	78	4.10
Low	75	4.49

5.3 Limitations

The subjects of this research were not a random sample. The students were from our partner elementary schools in the middle academic band. Thus, the findings discussed in this paper might not be applicable in (or generalizable to) high- and low-banding elementary schools. Further research to be conducted at other elementary schools in the other two academic bands is certainly needed for drawing a more comprehensive picture of elementary students' view of the affordance of LV in supporting CKB in the course of social inquiry learning.

Another limitation, which we regard as an inevitable one, is the *Hawthorne effect* [40] on the students. This effect refers to a phenomenon whereby people improve an aspect of their behavior in response to the fact of change in their environment, rather than in response to the nature of the change itself. Thus, the novelty of using LV for pursuing social inquiry learning might lead to temporarily increased participation in CKB among the students. Will the students' positive perception of LV's CKB affordance sustain? It is interesting to further study their feedback after their second or third use of this platform.

Last but not least, we realize that without interviewing the students (the lack of their qualitative feedback for complementing the quantitative findings) is a weakness of the study. However, this was a collective decision made by the eight General Studies teachers and our team under thorough consideration. The main reason was that after the term break the students needed to start preparing for an important examination⁶. We did not want to occupy the students' additional time for the present study.

6 Future Work

As mentioned in Sub-section 5.3, further research to be conducted in other two academic-banding schools so as to obtain a more comprehensive view from elementary students on LV's CKB affordance is a piece of our coming work. Apart from that,

⁶ The students' results in this examination contributed 50% marks to competing the admissions to secondary schools. The duration of the examination involved about 1.5 weeks.

through the present study, abundant discourse interaction pieces (at both village and house levels) and the corresponding timestamps were well documented. Further content-analysis work is worth carrying out to gain a more in-depth understanding of the students' CKB process in LV. We are also interested in studying the teachers' view on harnessing LV in social inquiry learning in school education, as "teachers are always the gatekeepers of educational innovation at school" [41]. And certainly, their feedback can also shed light on enhancing or improving the existing pedagogical and technological design of LV to better facilitate the implementation of this educational innovation in the school context.

7 Conclusion

Motivation and inquiry are both essential learning components that foster CKB to take place [13]. Gaming is regarded as an effective way to motivate and engage nowadays' school-aged students to learn [42]. Novice learners need structures of support (i.e. scaffolds) to assist them in building knowledge up [29]. Adopting the Stripping Model of Inquiry [5, 6], we have developed LV, a game-based CKB environment, to motivate and scaffold elementary students to pursue social inquiry learning. In this paper, we have discussed the pedagogical design of LV and the study from the students' perspective (involving 229 Grade-5 students) to evaluate LV's CKB affordance. The results showed that on the whole LV brought desirable CKB experience to the students, especially to those with low academic achievement. Concluded further with Law's [28] meta-elucidation⁷ of 12 CKB principles [11], LV is a desirable environment for fostering:

- a) *social dynamics conducive to sharing and open exploration of ideas*, reflected from LV's attributes of "Community Knowledge, Collective Responsibility," "Democratizing Knowledge," and "Idea Diversity;"
- b) *progressive inquiry orientation*, reflected from LV's attributes of "Epistemic Agency," "Knowledge Building Discourse," "Improvable Ideas," and "Constructive Uses of Authoritative Sources;"
- c) *socio-metacognitive orientation*, reflected from LV's attributes of "Rise Above," "Real Ideas, Authentic Problems," and "Embedded, Concurrent and Transformative Assessment;"
- d) *communal habit of mind*, reflected from LV's attributes of "Symmetric Knowledge Advance," and "Pervasive Knowledge Building."

In the preview of New Media Consortium Horizon Report 2014 [43], "games and gamification" is regarded as one of the most important developments in technology for K-12 education in the coming triennium. We believe LV and the findings discussed in this paper can provide insights for educational researchers and practitioners in technology companies who are pursuing work on developing and/or gamifying CKB environments to support social inquiry learning.

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⁷ Law [28] categorized further the 12 CKB principals into four CKB constructs.

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