Promoting Students' Interaction and Higher Order Thinking in an Undergraduate Health Information Literacy Course at MUHAS

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Abstract

Online learning environments have been adapted in higher education institutions around the world. However, it is not clear whether such adoption has yielded the expected effects on students' interaction and higher order thinking. The purpose of this research was to investigate whether the use of online discussion forum would promote students' interaction and higher-order thinking in an undergraduate health information literacy course. A total of 766 undergraduate students taking health information literacy course at MUHAS in a blended learning mode participated in the study. These students were engaged in five evidence-based practice topics using discussion forums - a moderate interactive learning environment as a pedagogical approach. Data included interviews and the content of online discussion forums. All qualitative data were analysed using ATLAS.ti software, Student t test was used to analyse the design effects realized over the three iterations and NetMiner 4- a social network analysis (SNA) software was used to analyze student interaction patterns. Results show that social interaction and students higher order thinking improved progressively over the three iterations. The changes in instructors' pedagogical strategies and the actions of students to learn from each other contributed to the marked students' social interactions and cognitive thinking. Thus, effective use of discussion forums in higher education can produce meaningful students learning interaction and higher order thinking.

Keywords: Interactive learning, higher order thinking, asynchronous design, social interaction, higher education

Introduction

The emergence of cutting-edge technologies has created much interest in e-learning investment in higher education. There are various online learning environments such as Google Class, Edmodo, Moodle, or Blackboard that can be used to share learning materials with students and promote collaborative learning. Some of these learning environments have been noted in the literature to extend students' cognitive abilities (Azevedo, 2005; Kim and Reeves, 2007; Lajoie, 2000). However, many of the online learning environments are limited to sharing instructional materials such as presentation files, links to websites and reading materials (Msonde & Van Aalst, 2014). These learning environments and their associated resources do not promote social and collaborative learning. This problem is internationally experienced. There has been an extensive use of e-learning environments in Tanzania higher education in order to help students develop scientific knowledge and required expertise. However, the learning effects so far have not been realised. It is important, in this context, to develop e-learning approaches that can be supported by technology to promote social interaction and metacognition (Azevedo, 2005). For example, students may harness the potential of social learning tools to share their ideas deeply during the learning process.

Online learning environments have widely been used in higher education institutions across the world to improve teaching and learning (Cassidy, 2016). However, any positive student learning effects depend largely on authentic learning activities (Herrington, Oliver & Reeves, 2003) and the quality of cognitive interaction occurring within those learning environments (Woo & Reeves, 2008). Therefore, promoting deep learning and cognitive development can be achieved through social interaction (Mercer, 1994). As such, designing online learning environments that encourage interaction and collaboration can bring meaningful student learning effect. Some previous research reported that the use of online discussion forum rarely includes the concept of cognitive interaction and idea improvement (Niu & van Aalst, 2009). This research focuses on investigating whether using online discussion forum would progress past mere discussions to deeper inquiry and knowledge advancements (Scardamalia & Bereiter, 2007).

Thus, the research had two goals. The first goal was to assess the effects brought by a moderate designed social learning environment in promoting student interaction. This learning environment provided support for peer interaction via

asynchronous discussion forums. The design was simple in terms of bandwidth requirements compared with the range of possibilities that online learning environments offers. The second goal was to investigate the effects of a designed social learning environment in promoting students higher order thinking. Therefore, this study investigated the following research questions:

i. To what extent do the designed social learning environment and pedagogical approaches enhance student interactions?
ii. Do the designs of social learning environments and pedagogical approaches improve students higher-order thinking?

The effectiveness of the designed social learning environments was analyzed in terms of inquiry threads and messages wrote during an online health information literacy course to determine the interaction pattern and advances in student higher order thinking during learning process.

Theoretical Grounding

The concept of student learning has been changing from individual knowledge construction toward social and collaborative learning (Bereiter & Scardamalia, 2002). Assumptions about collaborative learning can be related with the concept that student thinking reaches saturation in a social learning environment (Mercer, 1994). Such an assumption reflects the connectivist concepts of MOOCs which emphasises collaboration and engaging students in online social learning discourse (Rodriguez, 2013). Thus, social learning involves knowledge construction in an inquiry stance in which learners have the opportunity to articulate ideas into coherent meaning (Garrison & Arbaugh, 2007; Linn & Eylon, 2011).

In other words, students develop deep learning in social discourse (Woo & Reeves 2007). Most of social learning tools have capability to create social learning environments that enable these social discourses to occur. Tools such as *discussion forums* among others have capability to create social presence, which enables students to develop knowledge collaboratively. Thus, online discussion forums are potent learning tools that promote social interaction and deep learning. Most previous research (e.g. Bassili, 2008; Hew, 2009; Ng'ambi & Lombe, 2012) lacks empirical evidence to verify whether the use of social learning tools in an online learning environment has a significant effect on student interaction, thinking and achievement. The current research seeks to determine whether the use of social learning tools and associated pedagogical

approaches especially in health information course would create meaningful student interaction and higher-order thinking, particularly in countries with low-bandwidth and limited resources.

Pedagogical Designs

The researcher designed a moderate interactive social learning environment, which was implemented and evaluated in an instructional unit using three cycles of educational design research (McKenney & Reeves, 2012; Msonde & van Aalst, 2017). The design used discussion forums in order to boost social interaction (Sun *et al.*, 2018), cognitive engagement (Zhu, 2006) and higher order thinking (Darabi *et al.*, 2013; Msonde & van Aalst, 2017). However, the literature shows that students do not necessarily respond to the ideas of others in an asynchronous learning environment (Hewitt, 2005; Wise *et al.* 2012). Nevertheless, there are various pedagogical strategies that may be used to boost student interaction and engagement in learning (Hew & Cheung, 2008). Therefore, the researcher asked students to discuss a given topic on evidence-based practice (EBP), read the views of others and give comments on ideas written, or compose thoughtful questions and or answers in order to improve the previous ideas. These pedagogical strategies focused on promoting student's social interaction and cognitive thinking.

Design and Data

Setting and participants

The study was conducted at a public health university in Tanzania. This university had a well-developed technological infrastructure with a local area network connected across all of the university teaching and learning areas. Two instructors who taught freshman health information literacy skills course participated in this research. All 766 undergraduate students who were registered for this course agreed to participate in the study that used discussion forum – a moderate social learning environment in order to foster student interaction and thinking. The researcher considered other research designs, in which students would experience more than one design. But it was realized that both instructors and students required more time to learn and develop their practices with a specific design. Given the time limit, the researcher found it worth to settle on the present research design. The use of discussion forums was not common, so it was necessary for the students to develop some expertise in using the tool effectively.

Data collection

Data were obtained from interviews and the content of online discussion forums. Fifteen students were selected for interviews. Each of these students was interviewed four times before the intervention and at the end of each unit. Each interview was audio-recorded and lasted for approximately 20 minutes. The audio recordings were transcribed verbatim and respondents were invited to review their interview transcript. Online discussions were also used as source of data. Five discussion forums were conducted with each discussion topic lasting for 2 weeks. The students' messages in online discussion forums were crucial source of data for determining the level of student interaction and attainment of higher order thinking during the process of learning.

Data analysis

All interviews were transcribed verbatim and entered into ATLAS.ti software for coding and analysis. The coding of interview transcripts helped to acquire a deeper understanding of the students' views about learning before and during the three iterations. The researcher coded all of the interview transcripts and generated a set of codes. A number of recurring codes were clustered into dimensions (main codes) and sub-codes. To establish coding reliability, the sub-code descriptions and associated examples were given to an independent coder for checking. The researcher and the independent coder agreed on 30 of the 35 different types of sub-codes. Inter-coder agreement was 0.819 (Cohen's kappa), suggesting excellent inter-coder agreement (Gwet, 2012). Discrepancies were resolved through negotiation. The researcher refined the sub-codes and re-coded all of the data using the refined coding scheme, which comprised three main codes: *teaching presence, interactivity and engagement*. Similarly, the researcher used NetMiner 4 social network analysis (SNA) software to analyse the online discussion forum log files, which generated patterns for post-writing efforts, network densities and interactions cliques (Scott, 2012).

Moreover, content analysis was applied to the online discussion log files to analyse advances in the students' thinking. The researcher read the messages in the sampled Moodle discussion forums in order to understand the conversational trends. Various themes across the three iterations were identified and organised into inquiry threads, which were entered into ATLAS.ti for coding. The researcher developed a coding scheme based on the Practical Inquiry Model (Garrison *et al.* 2001) which was used to analyse the messages in the inquiry threads. The four cognitive dimensions in the Practical Inquiry Model

(*triggering event, exploration, integration and resolution*) were adapted. The researcher developed most of the codes using data from discussion forum 1. He improved the code descriptions and organized them into main and sub-codes which were later given to independent coder for checking. The researcher and independent coder were in agreement on 22 of the 29 sub-codes. Statistical analysis using SPSS was carried out to determine the inter-coder agreement. The level of inter-coder agreement measured .816 (Cohen's kappa), which was statistically significant, at $p <.0005$. The Kappa value was above .7 (70%), suggesting excellent inter-coder agreement (Gwet, 2012*)*. The discrepancies between them were resolved through negotiation, then the researcher revised the coding scheme based on the agreement reached and re- coded all of the data.

Results

The results are presented in several subsections. First, data about the students' views about online learning before the intervention was presented followed by their views on it during the intervention. Next, the data on the students' social interaction and advances in student thinking were presented.

Students' views on learning before the intervention

The main themes that emerged from data in this phase were *interactivity* and *teaching presence*. The term *teaching presence* refers to the acts of instructors to connect and facilitate online discourse in order to promote the student's interaction and cognitive thinking. It was revealed that before the intervention, students had not experienced social learning in an online environment. Most of them harnessed the capability of the Internet to learn in isolation. As such, the students were uncomfortable with the absence of social contact. Since most students shared similar views, the excerpt below has been chosen to exemplify their perceptions.

I have never used the Internet for sharing ideas with others. Rather to search information that meets my learning needs. The reason is that most online courses provide only notes and you are left without any assistance from the teacher to guide you on what to be done. This kind of online learning leaves us with a lot of learning misconceptions. (P52:21; 32:32)

This except shows that the students had little experience to harness the potential of social learning tools in sharing ideas. They wanted more *interaction to share their knowledge* with each other and with the *teacher in an* e-learning course. As such, they relied on individual and isolative learning. These results were common and

consistent with previous studies (Msonde & van Aalst, 2014; 2017). What is interesting here is the willingness of the students to learn in an interactive online learning environment.

Students' views on learning during the intervention

The researcher analysed the interview transcripts in each iteration in order to obtain a clear picture of how the students perceived their learning and how this learning developed. Three main theme, teaching presence, student interaction and engagement with contents were realised throughout the three iterations. The results showed that the use of discussion forums helped students to develop social learning culture. The instructors in this learning experience played a vital role in facilitating and engaging the students in *social learning*:

> It was interesting to have various topics on evidence-based practice during online discussions. The instructors took time to guide the discussion. They encouraged us to share ideas and provide constructive arguments based on evidence. The critiques received from both the instructors and fellow students during online discussions helped us to reach into common agreement on the topic we were discussing (P75:35; 14:22).

This excerpt shows that the teaching presence during online discussion helped students to experience social learning (collaborative knowledge construction) which culminates to deeper learning. The actions of the instructors in encouraging the students to provide constructive arguments based on evidence deepened their level of inquiry, which resulted in higher-order thinking. The level of social learning developed progressively over the three iterations. The students' social interactivity and idea exploration and development changed gradually based on the teacher's pedagogical changes. The except below exemplify such views:

> The teachers provided some guidelines that necessitated us to become active and think deeper during our discussion. We were required to read extensively so as to get supporting evidence on what you want to argue before asking any questions or giving a comment to ideas from others (P75:110; 22:22).

It is clear from the above excerpt that students were explaining the effect brought by the instructors' pedagogical strategies used during online learning. Such instructional strategies resulted in the students' engagement in reading

extensively educational material that deepened their understanding of the lessons. They were also involved in social discourse (*interaction)* which helped them to create knowledge socially and achieve higher-order thinking.

Students' learning processes during the interventions

Students' learning process was analysed in terms of student interaction patterns. Social network analysis (SNA) was used to determine the students' interaction patterns: their efforts in post writing, network density for posts linking and clique analysis.

Student post-writing effort. Three of the five discussion forums (1, 3, & 5), one from each iteration, were randomly selected to demonstrate the student posts writing efforts. Results from a paired sample t-test, given in Table 1, show that there was a significant difference in mean for post-writing effort during iteration 1 (M=2.86, SD=1.49) and iteration 2 (M=3.17, SD = 1.31) forum discussions; t (68) =1.590, p=.007. Similarly, a significant difference in mean between iteration 1(M=2.86, SD=1.49) and iteration 3 (M=4.69, SD = 1.36) discussion forums; t (68) =3.913, p=.000.

Table 1: Inferential statistics of posts writing

| Pair/iteration	Mean	Std. Deviation	t	df	Sig. (2 tailed)
Iteration 1	2.86	1.49	1.809	68	.075
Iteration 2	3.17	1.31	1.590	68	.007
Iteration 3	4.69	1.36	3.913	68	.000

Network density for post linking. The same discussion forums chosen were further used to analyze the student post linking patterns. Table 2 shows the coded written messages to establish the way students were *building on the ideas of others during online discourses.*

Table 2: Network density of posts linking

Iteration	Total written posts	Number of posts linked	% of linked posts	Density of linkedposts	Density of the whole network
Iteration 1	810	198	24.40	0.025	0.191
iteration 2	1350	445	32.93	0.046	0.303
Iteration 3	1452	709	48.84	0.087	0.409

The data in Table 2 show that there were improvements in idea linking during online discourse, such that student idea linking developed gradually over time. Such improvements were extensive during the second and third iterations as

depicted in Figure 1 of the resultant image of social network density of the linked posts of the whole network.
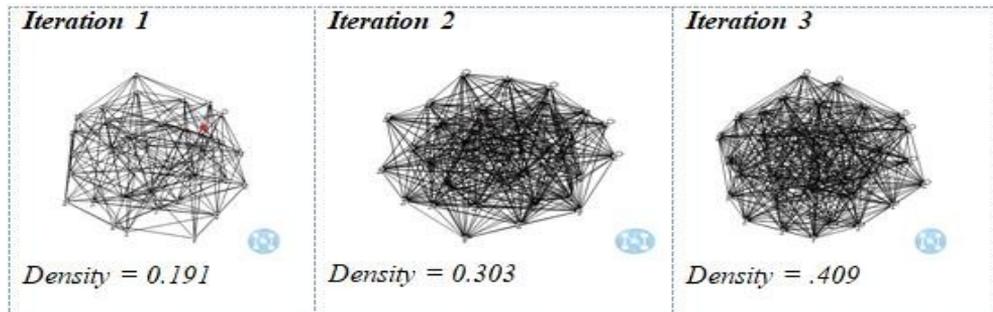
Figure 1: Social network density for idea linking

Clique analysis. This is a sub-set of a network in which members become closely tied to one another (Zhang *et al.*, 2009). Other scholar referred clique analysis as a social structure, which exists in an online learning community (Scott, 2012). Thus, cliques become more useful for determining interaction patterns. It reflects the collective cognitive responsibility occurring in online learning communities. Data presented in Table 3 show that there were few cliques in the first iteration with relatively high cohesion index. Such a situation implies that students demonstrated high levels of interactions within a clique.

Table 3: Clique analysis for idea linking

Iteration	Total cliques	Average size of clique	Number of cliques student belongs to	Number of cliques instructors belongs to	Mean cohesion index
Iteration 1	11	5	3	9	3.84
Iteration 2	28	6	16	14	2.16
Iteration 3	97	7	60	42	1.75

However, the number of cliques increased dramatically in the third iteration, which suggests that students had more interaction and collaboration during online discourse. Although there were increase in number of cliques over the three iterations, but the corresponding cohesion index decreased. Such decrease implies that students demonstrated high community-wide interaction with a reduced closeness between students within cliques.

Characterising student thinking

The researcher conducted an inquiry-thread analysis to examine the way student developed their thinking. The question–answer or idea–comments exchanges from the sampled three discussion forums (1, 3, & 5) become crucial data for this analysis. The results presented in Table 4 show that students initiated 17 inquiry threads and wrote 3612 messages whereas instructors initiated 18 inquiry threads and wrote 242 messages that most of them were in form of questions. On deeper analysis it was noticed that the instructors asked students questions that provoked them to come up with ideas that addressed the problem under discussion. They also asked students to develop further their ideas in order to deepen their thinking. These kinds of questions were categorised as questions *for* ideas and questions *on* ideas respectively (Zhang *et al.* 2009; Msonde and van Aalst, 2017).

Table 4: Messages and instructors asked questions

	Threads		Messages		
Iteration	**Instructor initiated**	**Student initiated**	**Instructor**	**Students**	**Total**
Iteration 1	6	5	58	810	868
Iteration 2	7	5	64	1350	1414
Iteration 3	5	7	120	1452	1572
Total	**18**	**17**	**242**	**3612**	**3854**
			Categories of instructor's asked questions		
			Questions for idea	*Questions on idea*	
					Total
		Iteration 1	13	17	30
		Iteration 2	21	34	55
		Iteration 3	10	50	60
		Total	**44**	**101**	**145**

Moreover, data in Table 4 shows that there were few questions *for* ideas over the three iterations. However, the instructors asked more questions *on* ideas that were numerous in the second and third iterations. The *instructor presence* and the kinds of questions asked not only minimised the issue of student isolation but also deepened the level of student inquiry.

Advances in student thinking

The researcher analysed the same discussion forums 1, 3 and 5 messages to determine advances in student thinking. The results presented in Table 5 show that during online discourses the students made factual statements (60 coded

instances), provided assumptions on problems (76 coded instances), gave explanations (78 coded instances) and elaborations (72 coded instances) of what they were discussing.

Table 5: Advances in student thinking

Codes for exploration and idea improvement

Iteration	Facts to problem	Problem conjecture	Explanation statements	Elaboration statements	Explanation seeking questions	Clarification seeking questions	Total
Iteration 1	15	13	15	12	20	9	84
Iteration 2	16	26	30	27	50	42	191
Iteration 3	29	37	33	35	81	68	283
Total	**60**	**76**	**78**	**72**	**151**	**119**	**558**

They also asked questions seeking explanation (151 coded instances) and clarification (119 coded instances), using "what," "how," "why," and "what if" statements. These types of questions extended the students' thinking and were extensive in third iteration.

Knowledge integration and resolution

The researcher analysed messages in the discussion log file to identify students' activities that involved an act of integrating various ideas into coherent meaning. The term integration can be defined in terms of building on ideas of others, bridging statements as well as providing reflective statements (Linn & Eylon, 2011). Table 6 shows that students expanded on ideas of others (101 coded instances); provided bridging statements (70 codes instances); and made reflective statements (75 codes instances).

Table 6: Knowledge integration and resolution

Iteration	Building on others idea	Bridging knowledge	Provide reflective statements	Total
Iteration 1	12	11	3	26
Iteration 2	20	10	35	65
Iteration 3	69	49	37	158
Total	**101**	**70**	**75**	**249**

It is clear that knowledge integration increased over the three iterations. However, the students' knowledge exploration, integration and resolution were gradual and progressive albeit much higher in the third iteration.

Discussion

Findings of this research have been discussed in terms of the effect of the course design on (1) students' interaction and engagement and (2) advances in student higher order thinking during their learning process.

Student interactivity and engagement

Student interaction and engagement with contents in an online discourse play an essential role in promoting productive dialogue. Online learning environments that emphasise this kind of learning requires instructors to understand not only the way effective online instructions are designed (Moore, 2016), but also how to facilitate students achieve meaningful interaction (Martin & Bolliger, 2018). In this study, instructors created a moderate social learning environment essential for these dialogues to occur. Such enhanced dialogue led students to develop deeper learning (Woo & Reeves, 2007). A good example is where students become engaged in deeper dialogue in online discussion forum to explore ideas about PICO concepts and types of clinical questions. They did so through asking their peers productive questions as well as critiquing the ideas of others on how clinical questions can be asked using PICO format.

These findings are encouraging in that using online discussion forums can have a worthwhile effect in promoting student engagement with what they were learning which culminates to deeper thinking. However, such learning progress does not come by its own, rather the nature of instructional strategies used as well as the *instructor presence* contributed to enhanced interactions and student engagement with contents. The literature shows that instructor *p*resence in online learning environment has been considered as a promising mechanism for developing learning community (Shea, Li, & Pickett, 2006) and a powerful strategy that minimises the issue of student isolation. For example, during an online discourse, instructors asked students higher level questions (Ertmer *et al.*, 2011) that required them to give ideas on their understanding of certain concepts under discussion. The instructors also wrote follow-up questions to students' written ideas on various inquiry problems. Such kind of questions deepened the inquiry and created students social and cognitive dynamics.

The growth of social and cognitive dynamics was useful for determining the student interaction patterns. Therefore, it can be argued that effective use of discussion forums in online learning environment can produce positive learning effects. Thus, instructors of higher education institutions in Tanzania need to harness the potential of discussion forum in order to bring about positive student learning effect compared with the acts of just posting contents to the online learning environments (e-learning platform).

Advances in student higher order thinking
The fundamental process for knowledge construction and student thinking occurs in a social learning environment. The findings from this research revealed that social and cognitive dynamics were evident over the three iterations. Students explored various inquiry problems and reached knowledge advances through social learning. The students managed to integrate knowledge and repertoire of ideas beyond the subject matter they were learning. This study used a modest online social learning environment (discussion forum) to deepen the inquiry problem leading to knowledge advancement and deeper thinking. These findings are contrary to some previous studies that showed the use of discussion forum rarely improved student ideas during learning (Niu & van Aalst, 2009).

In contrast, this study used online discussion forum to deepen inquiry problems that led students pursuing health information literacy course to acquire higher order thinking. They perceived learning to be much more interactive, collaborative and engaging, which developed their curiosity and contemplative ability. For example, the use of *questions on ideas and questions for ideas* deepened the level of that inquiry (Zhang *et al.*, 2009) especially when students associated the PICO concept in formulating relevant clinical questions. During the online learning discourse, instructors invested a lot of time to support and facilitate the online discussions by asking students more questions on ideas. As such, the level of student higher-order thinking improved from the first iteration and continued to improve in subsequent iterations.

An interesting finding from this study is that enhanced students' interaction and thinking were associated with instructional strategies used during online discourse that led students to achieve meaningful learning. Based on these findings, it is surprising to see unrealized online learning effects while universities have sound technological infrastructure to allow effective pedagogical designs and practices (OECD, 2015). Therefore, instructors need to work out of

functional fixedness when designing efficient online learning environments using the available technology in order to help students acquire meaningful learning.

Limitations and Further Research

This study had some limitations. First, the study used only discussion forum – a moderate social learning tool to foster student learning. It would be useful for further research to use more social learning tools in order to realise the added educational benefits that can be brought using those tools. Second, to know more whether the design work well it was crucial to implement the design to multiple courses. Thus, further studies should involve more instructors teaching other courses or be implemented in different universities with similar contexts.

Conclusions

Findings from this research reveal that the design of a moderate social learning space improved student social interaction and thinking. They advanced from isolative learning to collaborative learning and progressively improved thinking over the three iterations. These advances were modest during the first iteration, but extensive in the second and third iterations. Since, the discussion forum is a low bandwidth, therefore, it is a promising direction for universities in Tanzania to take for promoting social interactions and meaningful learning.

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