HOW DO WE KNOW WHAT IS HAPPENING ONLINE?: A MIXED METHODS APPROACH TO ANALYSING ONLINE ACTIVITY

ABSTRACT

The purpose of this paper is to discuss the process of analysing online discussion and to argue for the merits of mixed methods. Much research of online participation and e-learning has been either message focused or person focused. The former covers methodologies such as content and discourse analysis, the latter interviewing and surveys. The paper discusses the strengths and weaknesses of these approaches in the context of a study of an online social educational network for gifted students. The design of this study included the use of content analysis, visualisation diagrams, interviews and questionnaire survey in order to understand the nature of online discussion and the experience of taking part. It was found that the message focused analysis provided insight into participation and interaction patterns whereas the surveys and interviews enabled access to members' preferences and attitudes. The contribution of the paper is to argue for a mixed approach in which different types of data can be compared and contrasted. While the use of mixed methods in social research in general has long been suggested, its adoption in the field of online learning is yet to be widely established, possibly due to its time consuming and demanding nature. Despite these constraints, a mixed methods approach is advocated as it allows for a comprehensive picture of the use of the network and the experience of online participation.

KEYWORDS

Online discussion, mixed methods, data analysis, e-learning.

1. INTRODUCTION

There has long been interest in developing forms of online collaborative learning in both formal and informal contexts. These developments have provided researchers with the challenge of describing and evaluating the learners' experience of participation and the online archives that they create. In addressing this challenge researchers have developed a range of methodologies and methods, many of which can be divided between *focus on message / focus on participant*.

Message focused analysis typically begins with an analysis of archives in respect to number of messages and breakdown of messages by sender and by group (e.g. gender or cohort in formal learning). Social network analyses have enabled researchers to go further and explore the nature of interaction within members of a group (e.g. de Laat et al., 2007; Rabbany et al., 2013) and more recent learning analytics have tried to draw generalisations

concerning academic performance from patterns of online activity (e.g. Agudo-Peregrina et al., 2014). More fine grained methodologies include content analysis (e.g. De Wever et al., 2006); conversation analysis (e.g. Stahl, 2005) and discourse analysis (e.g. Littleton & Whitelock, 2005; McConnell, 1994). A further interesting, though underdeveloped, line of content analysis has concerned justification and argumentation (the two terms have been interlinked). For instance, Lee et al. (2005) compared gifted students' scientific knowledge and research abilities before and after their participation in an online argumentative discussion; Baker et al. (2003) examined secondary students' understanding of 'the space of debate'; and a more recent study by Blake and Scanlon (2014) examined the possibility of using an online tool called InterLoc as a way to assess the quality of discussions. In contrast to message analysis, person focused analysis has typically included interviews and surveys of learners' attitudes to online participation, their backgrounds, and their evaluation of their experiences online. At times, more ethnographic approaches have been undertaken, most notably Lindtner et al. (2008), which have looked at the physical context in which learners (in this case game players) participate.

Both message and person focused approaches, and the particular methods within each, have their advantages and disadvantages. For example, it is an obvious step to provide data on numbers taking part in online debates and the frequency with which individuals or groups post as these will say something about the intensity of the discussion. Indeed, by themselves surveys and interviews concerning attitudes may lead to rather misleading conclusions about participation so that, when asked, respondents typically show a great deal of support for *the idea* of online collaboration which is not always borne out by actual online activity.

It is not, however, straightforward to explore the quality or nature of online discussion, and message archives are open to different types of interpretation (De Wever et al., 2006). In-depth content analysis was introduced by Henri (1992) and taken forward by, amongst others, Gunawardena et al. (1998) to judge the quality of online interaction and of the learning experience. Yet, while researchers have claimed an objectivity in their analyses doubts remain. For example, Naidu and Järvelä (2006, p. 101) noted that 'keeping the complex characteristic of human learning in mind, it is never possible to find full evidence of learning from 'traces', such as computer notes of discussion threads'. Hammond (2015, p. 229) also questioned the assumptions made about participation arguing it was 'easy to be sanguine about the affective and motivational gains from participation in these contexts and to identify a process of 'knowledge building' without asking difficult questions as to the status of that knowledge.' A further problem in content analysis is that a focus on messages in archives may lead to the erroneous assumption that those who did not send messages gained nothing from reading / reflecting on others' messages. 'Quiet participation' (or so called 'lurking') may be important to the maintenance of community and may be not just

tolerated but welcomed by active participants – something that would not be uncovered without directly interviewing members of forums (e.g. Takahashi et al., 2003).

A mixed approach seems a necessary way of addressing the limitations of solely person or message based analysis. Of course the argument for a mixed methods approach in social research in general has long been made (e.g. Johnson & Onwuegbuzie, 2004) while Dennen (2008) and Naidu and Järvelä (2006) amongst others have noted that those studying online learning need not stick to one method of analysis. Mixed methods enhances the trustworthiness of research findings by providing confirming, complementary and contrasting sources of data. For instance, Wee and Looi (2009) in looking at the social construction of mathematical knowledge in quasi-synchronous chat environments among junior college students in Singapore, compared their interpretation of online discourse with participants' own interpretations. de Laat et al. (2007) used content analysis, interviews and social network analysis to investigate a networked learning community of Master's students noting the value of each method: content analysis provided data on the content of interactions, social network analysis described the patterns of interactions and interviews provided data about attitudes. Schrire (2006) incorporated content analysis into a multiple case study of three asynchronous computer conferences among doctoral students of computing technology in education at a university in the USA in order to address 'what happened' and 'how it happened' questions. Hammond and Wiriyapinit (2005) carried out an interpretive case study using a variety of methods including questionnaire survey, text analysis and interviews and illustrated both the value and the limits of triangulation.

However, even if there is, at least on intuitive grounds, much to recommend it, mixed methods is not a routine strategy and there have only been sporadic attempts to reflect on its methodological possibilities. This paper then addresses a gap by looking at the use of a mixed methods approach to describing 'what was going on' in one online community.

2. THE STUDY

This research involves a social educational online network, namely IGGY. IGGY was created in the UK by the University of Warwick for academically gifted young people, aged 13 to 18. According to IGGY's database, up to March 2016 the network had around 7000 active members. IGGY has members from all over the world, though most live in the UK (n = 6547). Around 60% are 16 to 18 years old and the rest 13 to 15 years old. The majority of the members are female but data on gender have not been routinely collected. An important feature of IGGY is the high level of participation safety – for example the network is closed to non-members and non-disclosure of personal information is ensured through regular monitoring of communication by organisers. IGGY can be regarded as an unusual or unique online network offering a hybrid of social and individual learning. It feels open in that members tend not to know each other in person, but closed as students usually need to be

recommended by a teacher in order to join the network (for a more detailed explanation, see Charalampidi et al., 2014).

The IGGY network consists of five sections; *Profile, Members, Debate, News and Events, Knowledge*. Of particular importance to the members are the Debate and the Knowledge sections. The *Debate* section is broad and may include anything that might be of interest to the members. Debates can be initiated by members or mentors (these are local university students or members of the IGGY staff). Debates are moderated and, reflecting the ethos of IGGY, while they tend to be conversational they are also discursive and are seen by members as different from the everyday social networking sites in which they participate. Meanwhile, the *Knowledge* section contains learning material grouped around academic categories such as Maths, Science, History and Politics, and Creative Writing. IGGY does not offer its members a guided programme, rather members are expected to identify for themselves relevant challenges. These cover topics of interest to the community but are not matched against any particular awarding body's programme of study. Participation in challenges is not formally assessed but is led by members of the IGGY team, the mentors or invited academics.

Researching IGGY has thrown light on online participation and interaction patterns and on the notion of giftedness. Underlying the various questions posed while researching IGGY has lain a wider question of how to describe what was going on online. To address this question we employed a mix of methods, including interviewing, questionnaire survey, content analysis and visualisation diagrams, on an expectation that our understanding of IGGY would be strengthened by the contribution of each method.

The approach was an iterative one. For example, in the early stage of the research, we relied on interviews with highly engaged members to orient us to the idea of IGGY and the experience of participation (see Charalampidi et al., 2014). However, a wider picture was needed and a questionnaire, revised from an earlier pilot, was prepared and uploaded on the network for a period of approximately eight months. Throughout this period a content analysis of messages from discussion forums was undertaken. There is not the space to present all the findings from our exploration of this network, instead this particular paper focuses on the methodology. It considers the methods used, with examples of using the methods and the benefits of a mixed methods approach.

3. THE METHODS

In line with our earlier categorisation we look here at message focused and person focused analysis.

3.1. Message focused analysis

Analysis was carried out on posts found in the debate section of the network. IGGY had designated 16 broad topics for debate at the time of our analysis: *Writing wrongs essay competition; Unitracks; University offer holders; Homework help; IGGY community hub; Help and feedback; Student mentors; Careers and personal development; What's it like to be gifted; Education and the internet; Science; Maths; History; English and creative writing; Politics; Law*. These we grouped into four categories: *cognitive; social / moral / political; personal development; administrative.*

Some of these debates required short, quick answers such as *Three Word Story?*, *First Thoughts in Mind* but others were discursive covering questions such as *Who Believes in Evolution and Why/Why not?*. We decided to apply a more fine grained analysis to some of these debates including *Is Homework A Waste Of Time?, What Is The Best Place You've Ever Been To On Holiday?, How Do You Tell If Someone Is Gifted?* and *Studying Law At University.* These debates were representative of the cognitive, social / moral / political, personal development categories mentioned above, but not the administrative category. A further criterion for selecting debates was that they evidenced the participation of members who had been or would be interviewed by the researchers. This meant that in interviews we could refer back to examples of debates and of participation and vice versa.

Message focused analysis began by reading the forums and 'getting a feel' for the discourse. This was beneficial in three ways: it provided access to tangible examples of knowledge claims made in earlier interviews; it enabled the identification of debates that were of particular relevance to our study, and it stimulated the formation of interview questions that examined aspects of these debates in more depth. After considerable trial and error, our content analysis focused on identifying large units of meaning and contained the key codes *Triggering a discussion (T), Inviting a response (R)* and *Stating (S)*. This three-way categorisation had the merit of not being overly complex while still allowing the identification of situations in which interaction was invited (the T and R codes). The third code (S) allowed a focus on how members justified their opinion and made claims to knowledge. The decision to investigate justification was also based on our observation that classroom teachers spent a great deal of time asking learners about the moral, practical and academic basis for the judgements they reach and we wanted to examine how this was done in different online contexts. Thus, subcategories looked at how participants drew on external sources, general knowledge, accepted facts, and on their own experience and value judgements to support their arguments. The full list of codes and sub codes is illustrated in Table 1.

Insert Table 1 about here

Apart from analysing the debate transcripts in terms of functions of posts, we identified who interacted with whom using visualisation diagrams. The diagrams were created via the software yEd into which data were imported manually.

3.1.1. Examples of message focused analysis

Selected examples of debates analysed are now presented. The first debate invited members to share their opinion regarding their best holiday destination. The second concerned the significance of homework and the third encouraged members to put forward any questions they might have had regarding studying law at University.

To illustrate the process of coding an excerpt from the debate *Is homework a waste of time?* is shown in Table 2. The first participant replied to the question set at the beginning of the debate and expressed her viewpoint and feelings regarding homework (coded S/Value judgements), which seemed to stem from her personal experience (coded S/Own experience). The second participant replied explicitly to this post and agreed with the first participant (coded R/Agreeing). She then justified her opinion by referring to generally accepted facts (coded R/General knowledge) as well as her own experiences (coded R/Own experience).

Insert Table 2 about here

Table 3 summarises the frequency with which codes were applied in these three debates. Two conclusions were immediately drawn. First, debates generated a different level of activity, for example here the second debate generated ten times the number of coded units as debate one. Each debate further had a different pattern of coding. For example, nearly seventy per cent of the coded units in the first debate were identified as making statements (in practice a sharing of personal experiences) while in the second debate just over half the coded units were responding and the third debate was dominated by trigger questions. This suggested that different topics provoked different forms of cognitive engagement, something we were able to follow up in interviews.

Insert Table 3 about here

Visualisation diagrams (Figures 1, 2, 3 and 4) enabled us to go further and to identify the key participants around whom discussions evolved. In the figures, the square nodes represent learner members of IGGY, the circles represent mentors or other members of IGGY staff, and the lines represent connections among the discussants. A connection was created whenever a participant was addressing (explicitly or implicitly) another participant. If within the same post a participant addressed more than one discussant (i.e. he/she replied to a specific participant but also set a question for all participants), more than one connection was created. The size of the nodes is proportional to the number of connections made. The more connections (lines from or towards the node) a participant had generated, the larger

the node. The turquoise octagon signifies those messages or parts of a message that did not address a particular discussant but rather all discussants in the debate.

Insert Figures 1, 2, 3, 4 about here

The diagrams helped in giving shape to the discussions. They showed that members often, but not exclusively, replied to individuals within the group, a pattern that could be described as 'one to many' or 'many to one'. A further observation made by looking at the diagrams was that even though most messages revolved around an initial post, the participant who triggered the discussion in all three debates did not contribute further to it. It was also clear that the mentors in the first and second debate (the circles in Figures 1, 2 and the enlarged Figure 3) were particularly active in sending messages and were frequently addressed when members replied. This suggested that the mentors' contribution was significant in encouraging further interaction, rather than triggering interaction in the first place. The second debate was of particular interest as it was one of the most popular in IGGY. In this debate, 122 students and 9 mentors participated. Figure 2 shows that apart from the main discussion, several subgroup discussions developed. Many messages were also directed to the group as a whole (see the turquoise octagon in the figure 2), which suggested that discussants in this debate were interested in other members' opinions.

3.2. Person focused analysis

A survey (n = 161 responses) was carried out comprising of 25 questions; 22 closed questions, two open-ended questions and one question that invited students to opt in for an interview. The closed questions included Likert scales, yes – no questions and multiple choice responses. The questions were divided in two broad categories; questions about the students' profile (e.g. gender, age etc.), and his/her online experience. The latter covered the themes of online behaviour and forms of engagement and provided quantitative data on issues such as membership duration, the frequency of accessing the network, the time spent using the network during a typical week, and the frequency of engagement with various types of activities. The survey also examined members' preference in respect to social / non-social activities, perceived benefits and reasons for using IGGY, feelings towards the community, constraints and suggestions for improving the online experience.

The use of the network was further explored through a series of semi structured interviews with twelve learner members and two mentors. Key themes that emerged from the interviews with the students concerned the users' profiles (hobbies, family, friends), the idea of giftedness (conceptions of giftedness, the label, feelings and/or problems related to it), their use of technology in general, and their use of IGGY (expectations, why join, why use, what do you do, benefits, online relationships and community, facilitators, constraints, suggestions for improvement). In the last round of interviews an additional strategy,

stimulated recall, was used which facilitated discussion of the composition of text and of intentions in contributing to particular debates. The face-to-face interviews with the mentors included questions about their role, students' participation in the debate and the knowledge sections, and online learning. They were asked to elaborate on the content they produced and how they came up with the topics or challenges they set, and how they defined a successful debate or challenge. They also compared IGGY with other networks with which they were familiar.

3.2.1. Examples of person focused analysis

The initial analysis presented an overview of the use of IGGY. It was found that members carried out a variety of activities in IGGY but the favoured ones were reading articles or watching videos. Members used IGGY for a number of reasons: to address lack of challenge at school, to access learning resources, to meet new people, to communicate with other members, and to learn about other cultures. Many members experienced educational (i.e. vocabulary development), cultural (i.e. knowledge of other cultures) and affective benefits (i.e. confidence in expressing their opinion) through their participation. In general, IGGY was seen as an educational community within which members felt trust, empathy and respect. The main constraint in using IGGY appeared to be lack of time.

Table 4 gives an example of the way the data were represented. Interesting in the table is that it shows that the most favoured activities were reading articles or watching videos, activities that might be carried out independently albeit in a social network. These activities appeared to be twice as popular as the social activities of reading and/or replying to debates. Doing quizzes or playing games were similarly independent activities and did not typically involve peer response. Participating in live chats and blogging was not favoured by any respondent. Of course social activity was valued – as seen in the willingness to take part in debates – but these data suggested that activity was not as socially oriented as for example community of practice theory would suggest. Data were broken down and there were often similar patterns of responses across gender and age.

Insert Table 4 around here

Interviews provided the detail for the general picture generated in the survey. For example, one interviewee (coded in our study as Female13) was classified as a frequent user of the network as she accessed it daily, spending between one and two hours in it. Female13 provided explanations and examples to support her idea that the network was helpful and valuable. She also expanded on debates to which she had contributed, read or initiated. She valued any type of debate, 'fun or more serious', that had something to offer her. She participated when she found the topic interesting, amusing, important or challenging, as in the debate *Is homework a waste of time?* (see Figure 2). She was motivated to contribute

further when different or opposing views were expressed (interviews were coded and this fell under the main code of motivation to take part, and the sub code persuading):
Yeah that homework is really important for our learning to progress. I just thought that I tried to make people see different views. People who thought that it wasn't important I tried to make them see that it actually is really important.

Notably, she replied to posts when she felt she had something to add to the conversation. Yet, even when she did not reply, she read and contemplated the messages and this gave insight into the process of quiet participation:
I just wanted to push it as far as possible so that they thought of different ways, but the others were so thought through I didn't know what to answer. There was nothing I could say, because it was just so well written and so well researched. I did look at them, I did come back to it.

She also shed further light on facilitators of participation and referred to the importance of social presence (social presence was a key code in the analysis). She believed that replying to specific members was useful in making them feel both accepted and confident as '*it shows that somebody has actually taken the time to read their message*'.

Mentors were also found to be one of the most significant facilitators of participation in all interviews. For example, a learner member (coded as Female2) talked about how the mentors contributed to the debates, providing a '*really really long, helpful, detailed explanation and links to several good resources which I used*'. She also explained that mentors enhanced the quality of a discussion:
Whenever a debate is going slow or nobody is really replying, they help (by) *post*(ing) *more questions and help you start thinking and if you are unsure about something, they answer in one or two days straight away*.

Learner members' views of what made a successful debate were often echoed by mentors. For this mentor (Mentor 2, Female) a debate could be judged on the quality and not the quantity of replies:
It (a successful debate) *will be one when members engage, I don't know how to describe a 'high level', but members engage in a way that they gain something from reading the article (…) the responses are more in-depth and the members are developing more opinions on things and they are kind of leading the discussion, you don't have to keep prompting, it's just the topic that over time it just keeps on going by itself (…) it doesn't matter if it was only one or two people that answered, it's if they learnt something of it or enjoyed something about it.*

Via the interviews we were also able to reach an understanding of how online participation benefited the learner members. A member (coded as Female1) said that she '*learnt a lot*

about many different things. When I first started looking at the debate section there was a whole bunch of stuff that I've never heard of before so that basically gave me the incentive to go and look it up and find out more about newer things.' Another female member (coded as Female12) felt that she improved her argumentative skills as well as her creative thinking:
It me made think about how to debate a lot more because debating at school wasn't really common so I didn't know fully how to develop an argument and back up my points and everything so it helped me with that and then also thinking outside the box. Some of the challenges they set they make you think outside of the standard way of thinking.

Learner members and mentors shared similar views regarding online learning. They explained that debating could be seen as learning as it stimulated rethinking about one's own ideas, thinking on new subject matters, judging other people's ideas and distinguishing opinions from facts. To the mentors, a crucial condition for learning to occur was the open-mindedness of the members, the justification of the viewpoints put forward by the discussants, and the rationality and sufficiency of their arguments:
I think it's possible, as long as the members that are in that debate are debating in a way that they are giving some logic, they are giving some reasoning behind their view. (Mentor 2, Female)

Another mentor (coded Mentor 1, Male), commented on how IGGY differed from other networks and maintained that:
IGGY members showed a significant level of maturity compared to the general public I'd see at the BBC website or the Guardian. While their opinions may be strong they were found more tolerant and phrased far better. They are the key differences.

One obvious limitation of the interviews was that of sampling. Not surprisingly those that volunteered to be interviewed tended to be among the most active of members and their experiences might not be representative.

4. CONCLUSIONS

The paper began by noting the variety of approaches to analysing online participation. Two main approaches were identified: message focused and person focused analysis. In our study we combined these approaches to exploit the opportunities afforded by each (Table 5 summarises the strengths and limitations of each method).

Insert Table 5 about here

Different sources of evidence provide different types of insight. In particular, the message focused analysis and the visualisation diagrams informed us about the structure of debates and showed how debates were triggered, who triggered them, who contributed and how.

The analysis gave clues as to how discussions were sustained and pointed to the key role of moderators. The content analysis gave us insight into the different sources of knowledge and claims to knowledge and how these differed depending on the nature of the discussion. This was important as a claim to academic knowledge needed to be founded on more than personal experience and should consider appropriate evidence. However, such analysis did not provide access to the participants' perceptions about what was happening online but rather an interpretation from an 'external' point of view. Thus the need for interviews to allow an in-depth exploration of the participants' experiences and offer answers to 'why' questions. Interviews had the additional potential of informing researchers about 'hidden' or 'quiet' participation. Alongside interviews, surveys enabled access to a wider sampling of the members and provided background demographic information, as well as other additional quantitative and qualitative data. This was beneficial in identifying subgroups with common characteristics.

The analysis of an online environment should not be treated mechanistically. For example, coding for content analysis was not chosen 'off the peg' but rather developed by ourselves to fit around the questions we wanted to ask. More importantly, while familiar methods of contrast, consistency and complementarity were used to triangulate findings this required a continual cross checking of different data rather than a simple aggregation. Indeed, based on constant comparison of data we were able to reach the conclusion that IGGY can be described as an educational community in which, through participation and interaction, members experience learning benefits, albeit with constraints on members' participation and differentiated patterns of participation.

A mixed methods approach is intensely time consuming and perhaps this explains its uneven use in the field. Yet the approach is a valuable one and we are in danger of making misleading claims about online learning if we rely on only one source of data.

REFERENCES

Agudo-Peregrina, Á. F., Iglesias-Pradas, S., Conde-González, M. Á., and Hernández-García, Á. (2014), "Can we predict success from log data in VLEs? Classification of interactions for learning analytics and their relation with performance in VLE-supported F2F and online learning.", *Computers in Human Behavior*, Vol. 31, pp. 542-550.

Baker, M. J., Quignard, M., Lund, K. and Séjourné, A. (2003), "Computer-supported collaborative learning in the space of debate.", in Wasson, B., Ludvigsen, S., and Hoppe, U. (Eds.), *Designing for Change in Networked Learning Environments: Proceedings of the International Conference on Computer Support for Collaborative Learning, 2003*, Kluwer Academic Publishers, Dordrecht, pp. 11-20.

Blake, C., and Scanlon, E. (2014) “Analysing online discussions in educational and work based settings”, in Bayne S, Jones C, de Laat M, Ryberg T and Sinclair C. (Eds.), *Proceedings of the 9th International Conference on Networked Learning 2014*, pp. 25-32.

Charalampidi, M., Hammond, M., and Boddison, A. (2014), “Exploring aspects of participation in an international online network for 'gifted' students - A research in progress.” in *Proceedings of EDULEARN14, 6th International Conference on Education and New Learning Technologies, in Barcelona, Spain, 2014*, IATED, Valencia, pp. 6250-6259.

de Laat, M., Lally, V., Lipponen, L., and Simons, R.-J. (2007), “Investigating patterns of interaction in networked learning and computer-supported collaborative learning: A role for Social Network Analysis.”, *Computer-Supported Collaborative Learning*, Vol. 2, No. 1, pp. 87-103.

De Wever, B., T., S., Valcke, M., and Van Keer, H. (2006), “Content analysis schemes to analyze transcripts of online asynchronous discussion groups: A review.”, *Computers and Education*. Vol. 46, No. 1, pp. 6-28.

Dennen, V. P. (2008), “Looking for evidence of learning: Assessment and analysis methods for online discourse.”, *Computers in Human Behavior*, Vol. 24, pp. 205–219.

Gunawardena, C. N., Lowe, C. A., and Anderson, T. (1998), “Transcript Analysis of Computer-Mediated Conferences as a Tool for Testing Constructivist and Social-Constructivist Learning Theories.”, in *Distance Learning 1998, Proceedings of the Annual Conference on Distance Teaching & Learning, in Madison, Wisconsin, USA*, pp. 139-145.

Hammond, M. (2015), “A Habermasian perspective on joint meaning making online: What does it offer and what are the difficulties?”, *International Journal of Computer-Supported Collaborative Learning*, Vol. 10, No. 3, pp. 223-237.

Hammond, M., and Wiriyapinit, M. (2005), “Learning through online discussion: A case of triangulation in research.”, *Australasian Journal of Educational Technology*, Vol. 21, No. 3, pp. 283-302.

Henri, F. (1992), “Computer conference and content analysis”, in Kaye, A. R. (Ed.), *Collaborative Learning Through Computer Conferencing*, Springer-Verlag, Berlin, pp. 117-136.

Johnson, R., and Onwuegbuzie, A. (2004), “Mixed methods research: a research paradigm whose time has come”, *Educational Researcher*, Vol. 33, No. 7, pp. 14-26.

Lee, E. Y. C., Chan, C. K. K., and Van Aalst, J. (2006), "Students assessing their own collaborative knowledge building", *International Journal of Computer-Supported Collaborative Learning*, Vol. 1, No. 1, pp. 277 – 307.

Lindtner, S., Nardi, B., Wang, Y., Mainwaring, S., Jing, H., and Liang, W. (2008), "A hybrid cultural ecology: world of warcraft in China.", in *Proceedings of the 2008 ACM conference on Computer Supported Cooperative work, in San Diego, USA*, pp. 371-382.

Littleton, K., and Whitelock, D. (2005), "The negotiation and co-construction of meaning and understanding within a postgraduate online learning community.", *Learning, Media and Technology*, Vol. 30, No. 2, pp. 147-164.

McConnell, D. (1994), "Managing open learning in computer supported collaborative learning environments.", *Studies in Higher Education*, Vol. 19, No. 3, pp. 341-358.

Naidu, S., and Järvelä, S. (2006), "Analyzing CMC content for what?", *Computers & Education*, Vol. 46, No. 1, pp. 96-103.

Rabbany, R., ElAtia, S., Takaffoli, M., and Zaïane, O. R. (2013), "Collaborative learning of students in online discussion forums: A social network analysis perspective.", in Peña-Ayala, A. (Ed.), *Educational Data Mining: Applications and Trends*, Springer-Verlag, Berlin, pp. 1-30.

Schrire, S. (2006), "Knowledge building in asynchronous discussion groups: Going beyond quantitative analysis.", *Computers & Education*, Vol. 46, No. 1, pp. 49-70.

Stahl, G. (2005), "Group cognition in computer-assisted collaborative learning.", *Journal of Computer Assisted Learning*, Vol. 21, No. 2, pp. 79-90.

Swan, K. (2002), "Building learning communities in online courses: The importance of interaction.", *Education, Communication & Information*, Vol. 2, No. 1, pp. 23-49.

Takahashi, M., Fujimoto, M., and Yamasaki, N. (2003), "The active lurker: influence of an in-house online community on its outside environment.", in *Proceedings of the 2003 international ACM SIGGROUP conference on supporting group work, in Sanibel Island, Florida, USA*, pp. 1-10.

Wee, J. D., and Looi, C.-K. (2009), "A Model for Analyzing Math Knowledge Building in VMT.", in Stahl, G. (Ed.), *Studying Virtual Math Teams*, Springer, New York, pp. 475-497.

Table 1. Codes used in content analysis.

Codes	How achieved (sub codes)	Examples
Triggering discussion – T	*Introducing, Maintaining, Asking, Acknowledging*	(T/Introducing) 'There are a lot of stereotypes surrounding intelligent people. How true do you find them?' (T/Maintaining) 'This is really nice. Thanks.'
Stating – S	Appeal to: *Reading, General knowledge, Facts, Value judgements (Aesthetic, Moral), Own experience, No reason given*	(S/General knowledge) 'Driving less can have enormous benefits for the environment, while walking and bicycling can also improve your health.' (S/Value judgement) 'I think academically gifted is showing ability in many academic subjects; talented is in one.'
Responding – R	*Disagreeing, Agreeing, Resolving, Expanding on previous comments* plus Appeal to: *Reading, General knowledge, Facts, Value judgements (Aesthetic, Moral), Own experience, No reason given*	(R/Disagreeing by appeal to own experience) 'But in my school we usually spend so much time checking everyone has handed the h/w, we might as well have done the work in that time!!' (R/Agreeing but no reason given) 'I agree nebiyah!'

Table 2. Is homework a waste of time? An illustration of the content analysis scheme.

Discussant	Post	Codes
AdrianaT	Homework is annoying, but we do just need to put up with it. It does get annoying, though, when the teacher just sets random homework for no apparent reason!!!! ANNOYED.....yes a lot!!!	S/Value judgements + S/Own experience
Female13	AdrianaT, I agree with you.	R/Agreeing
	Homework can be positive or negative depending on what subject it is or what is the content of the homework. In my opinion, homework is good when you can use it to do revision as you have already gone through it in class and so that you remember what you have done. Like when you leave the Science labs and Science doesn't interest you, you just completely forget about what you have done in lesson. Homework is there for that.	R/General knowledge
	However, homework can also be negative as I often get homework that has nothing to do with the topic we are currently studying and it's really hard to do it as you don't know the answer and that's when you spend a long time doing it. My teachers tell me that homework is supposed to take us on average 30-45 minutes but when there are homeworks like this, they take me on average an hour to two so I think homework should be related to the topic you are studying as it is a reminder for the lessons you have had that day.	R/Own experience

Table 3. Frequency with which codes were applied to three debates.

Debate	T (n=)	R (n=)	S (n=)	Total
What is the best place you've ever been to on holiday?	4	6	23	33
Is homework a waste of time?	38	199	105	342
Studying law at University	8	2	1	11

Table 4. Survey responses to the question 'What is your favourite activity?'

What is your favourite activity?	N=	%
Read articles or watch videos	91	57
Read and/or reply to debates	44	27
Do quizzes or play games	10	6
Take up challenges	8	5
Participate in competitions	3	2
Participate in live chats	0	0
Blog	0	0
No reply	5	3
Total	161	100

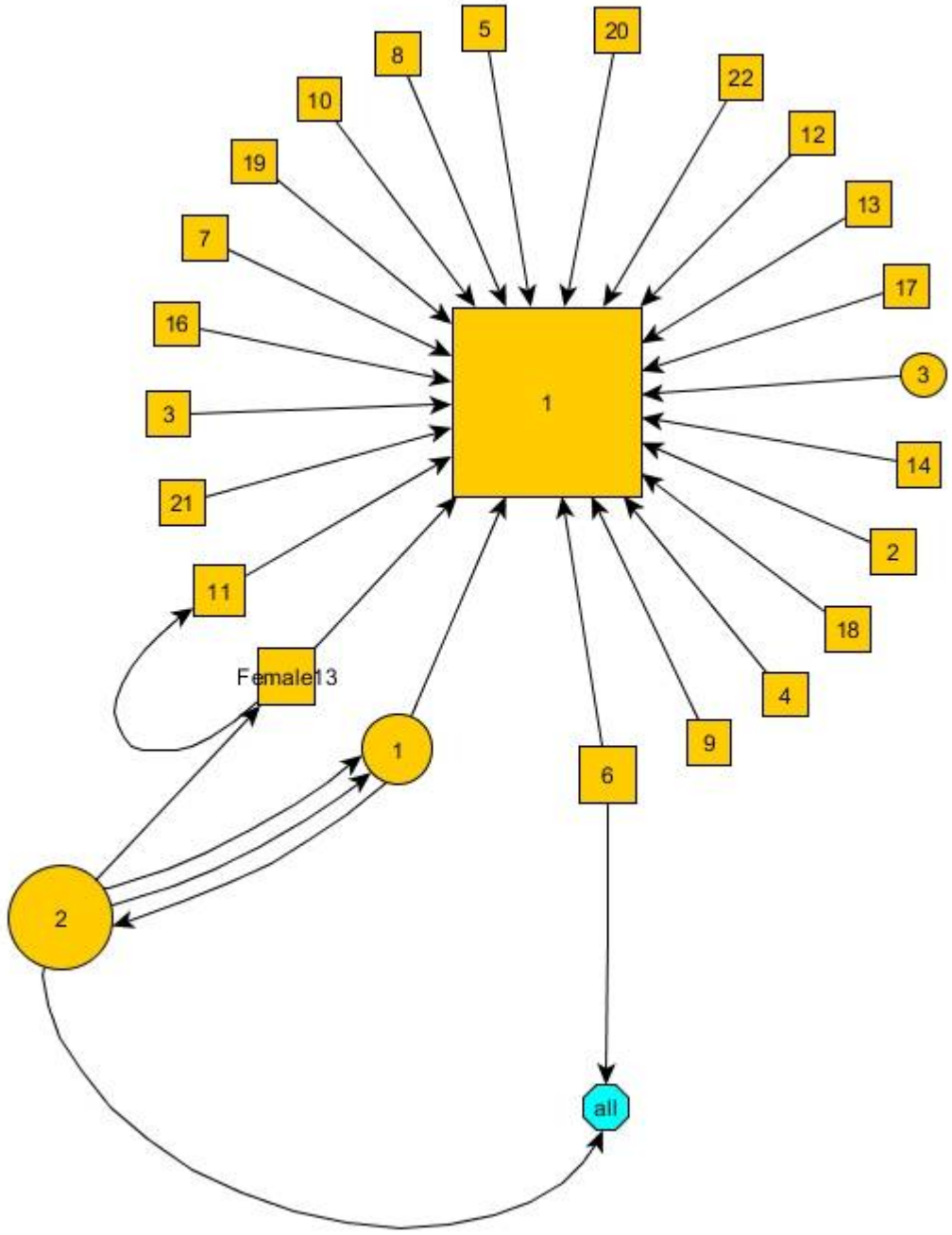

Figure 1. What is the best place you've ever been to on holiday? – Representation of interactions.

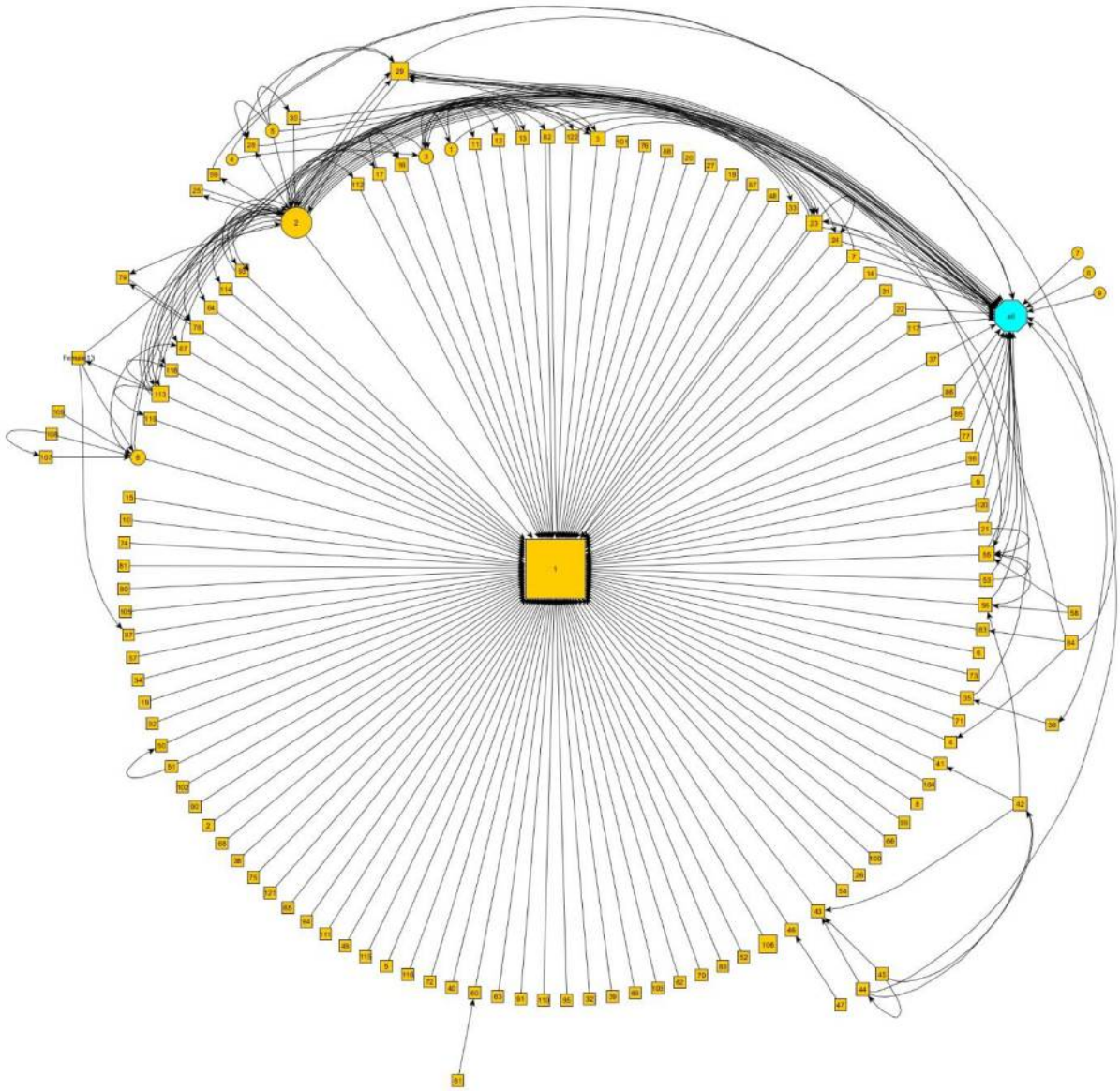

Figure 2. Is homework a waste of time? – Representation of interactions.

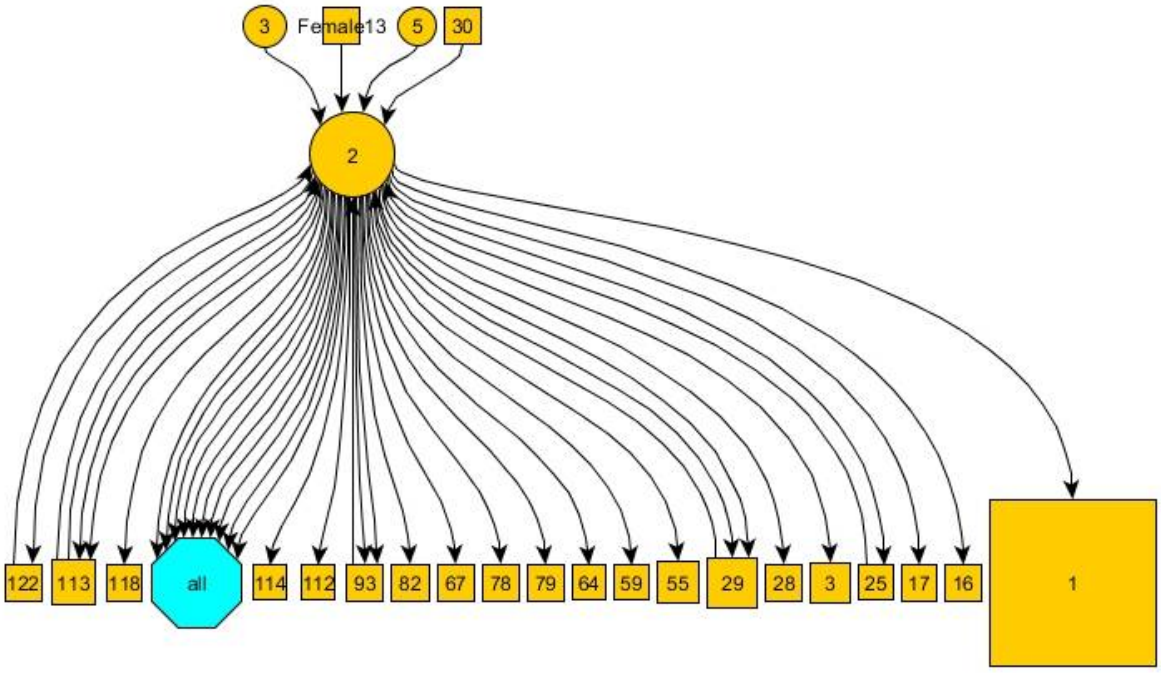

Figure 3. Is homework a waste of time? – Zooming in on a representation of interactions generated by the activity of an IGGY mentor (circle, numbered 2).

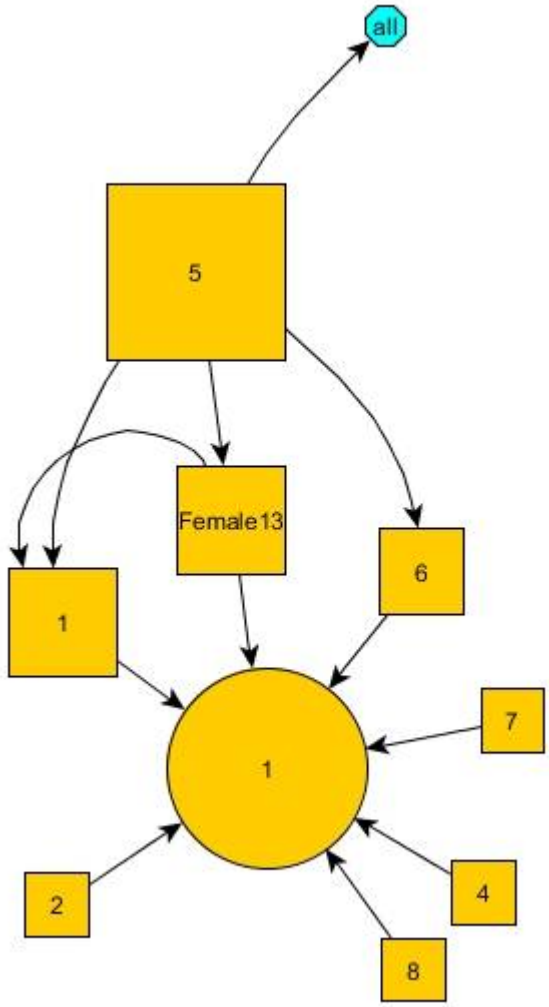

Figure 4. Studying law at University – Representation of interactions.

Table 5. Contribution and limitations of each method.

Methods		Enabled access to	Limitations
Message focused	Content analysis	▪ Patterns of participation across different topics ▪ Varied levels of participation ▪ Varied forms of cognitive engagement	▪ Time consuming ▪ Subjectivity in generating and applying codes and sub codes
	Visualisation diagrams	▪ Shape of debates ▪ Patterns of interaction between members ▪ Key participants ▪ Mentors' role	▪ Visual overload ▪ Data imported manually – not feasible for large sets of data
Person focused	Survey	▪ General use of the network ▪ Demographic information about members ▪ Data on attitudes (e.g. preferences) and behaviour (e.g. access frequency) ▪ Break down of data by age and gender and other variable	▪ Response rate ▪ Self-reporting of activity
	Interviews	▪ Members' explanations of 'what is happening' including 'how' and 'why' participate ▪ Insight into activity away from the network ▪ Insight into independent learning	▪ Sampling ▪ Time consuming ▪ Subjectivity in generating and applying codes and sub codes