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THE DEVELOPMENT OF A VIRTUAL LEARNING CLUSTER IN RURAL NEW ZEALAND SECONDARY SCHOOLS: A CASE STUDY

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Abstract

This paper reports the findings of a qualitative research study that attempts to identify the factors that have supported the development of a self-sustaining virtual cluster of secondary schools in a rural region of New Zealand. The school cluster offers classes in some selected subjects via Internet and videoconferencing technologies and was designed to meet the curriculum needs of students with no or little access to those subject areas. The programme is known as the Learning Exchange. Using Actor-Network Theory (ANT) and the associated process of Translation, the study has identified a number of factors that are considered necessary for the development of a learning exchange cluster.

Keywords: Actor-Network Theory, Distance Education, Learning Exchange, Virtual cluster of schools, Video-conferencing

1 INTRODUCTION

One of the disadvantages of studying in schools located in any rural area is having access to subject areas which are not part of a regular curriculum. The affected students and their school would then need to find alternative methods to access those resources. In response to this situation, a number of schools located in a rural region of New Zealand grouped together to form a cluster of schools, we call that SchoolNet¹. The school cluster is an online collaboration of schools that offers online synchronous classes for their students needing to study the subjects that are not available at their own schools. Students from member schools are enrolled in those classes with a teacher from one of the schools. Classes are taught over the videoconference for an hour once in a week for whole year. Since its inception, SchoolNet has developed and become a self-sustaining virtual cluster of 25 schools. Because of its success, the SchoolNet model has been adopted by 18 other school clusters across New Zealand. However, nearly half of the clusters have disappeared and only eight of them are currently using the Learning Exchange model. This research aims to address the problem of sustainability of virtual learning clusters by studying the factors that have facilitated the development of SchoolNet and is guided by the two research questions: How has SchoolNet developed and become a self-sustained Learning Exchange cluster? What are the factors that can mediate the self-sustainability of a Learning Exchange cluster? A qualitative case research method was adopted for the study and the Actor Network Theory (ANT) was used as a theoretical lens for the analysis of data collected during the study.

The next section briefly describes some key literature, followed by a brief description of ANT with its process of Translation. Section 4 outlines the research methods used in this study. Section 5 provides the key research findings through the phases of Translation. Finally, the Conclusion Section recaps the findings by pointing out the mediating and disruptive factors and describes the implications of the study.

2 OVERVIEW OF LITERATURE

Literature informs that for more than a century, distance education has been used in a variety of ways to meet rural learners and educators needs. The Correspondence School was followed by radio and television broadcasts (Moore & Kearsley, 2011; Garrison, 1997). More recently, the mediation of computers and Internet have enabled participants to interact via two-way communication systems with greater engagement opportunities (Veletsianos, 2010; Taylor, 2001). The adoption of synchronous and asynchronous telecommunication systems has turned distance education into a collaborative learning style of education (Anderson & Simpson, 2012; Carswell & Venkatesh, 2002). Videoconference (VC) is one of the systems that is utilised to allow the synchronous exchange of learning resources between two or more sites (Lawson et al., 2010; Brade, 2007). Studies such as Smyth (2005) and Greenberg (2004) also agree with the effectiveness of VC for collaborative learning. However, other studies such as Simonson et al. (2011) and Anastasiades et al. (2008) report that some programmes using VC struggle to succeed and the authors call for further studies to identify why that is the case.

A similar kind of changes can be observed in school's education where educators are taking advantage of online educational opportunities for shifting from the brick-and-mortar to emerging paradigms. Leidner and Jarvenpaa (1995) redefine learning as a constructivist process rather than objectivist. In the redefinition, a learner constructs his/her own reality of the objective world rather than having to understand an objective reality that already exists (Jonassen, 1991). The 'Connected School' suggested by Wenmoth (2010) is an example of such paradigm shift. However, the 'Networked School' proposed by Wenmoth (2010) settles down in the Social/Cultural camp, which suggests that "knowledge is not abstract; instead, it is rooted in context and culture i.e. it is situated" (Nilsen & Puro, 2005, p. 4). The Learning Exchange has theoretical roots in both the Connected and Networked School modes, indicating the programme has embraced the shift and adopted according to the changes.

¹ Due to the human ethics agreement with the research participants, their organisation cannot be named in any publication. Therefore, we have used the term 'SchoolNet' for referring to the group of schools.

The notion of *cluster* in the Learning Exchange can be rooted in the concept proposed by Michael Porter in 1990. According to Porter (1998, p. 78), “clusters are geographic concentrations of interconnected...institutions in a particular field”. Institutions in a cluster can be related as well as competing organisations; their grouping is to improve their performance, particularly to gain economic benefit (Kuah, 2002). The strategy signifies the need for collaboration even between competitors for gaining economies of scale. Previously the strategy was mainly interpreted for economic development; however, the focus has shifted to other areas such as a knowledge-based view of the concept (Bathelt et al., 2004). In Learning Exchange, the clustering strategy is to maximise educational benefits of schools that are related as well as competing organisations (Barbour & Wenmoth, 2013). However, the strategy in the Learning Exchange has been *adapted* for the ‘virtual’ instead of ‘physical’ grouping.

Given the self-reliant nature and the bottom-up developmental approach of the Learning Exchange clusters, very little information is currently available regarding the programme let alone the problem of disappearing clusters. Bolstad and Lin (2009) report students’ experiences. Barbour et al. (2011) discuss the Virtual Learning Network processes in general and do not particularly focus on the Learning Exchange. Powell (2011) briefly mentions some clusters that have easily adjusted to the Learning Exchange while others are struggling. However, the author does not identify any reasons to the problem. Therefore, the problem remains unknown as why some clusters struggle to stabilise and what are the facilitating and inhibiting factors necessary for the development of a stabilise learning exchange cluster.

From a broader literature perspective, few studies have attempted to identify the inhibiting factors for the development and stabilisation of videoconference-based distance education programmes. Simonson et al. (2011) identify five main barriers: organisational resistance to change, lack of shared vision, lack of strategic planning, slow pace of implementation and difficulty in keeping up with technological changes. Wolfe (2007) found the lack of managerial support an issue. Bolstad and Lin (2009) and Davis et al. (2007) identify the lack of managerial and government support as the common barriers. These challenges are only a few of the inhibiting factors need to be examined with regards to the Learning Exchange. Factors that support the stabilisation and self-sustainability of such programmes still remain unknown. The knowledge gap remains one of the key motivational factors for this study.

3 ACTOR NETWORK THEORY (ANT)

According to ANT, society is a network of human and non-human elements and relationship plays a key role in the making of that network (Callon, 1986; Latour, 1986; Law, 1992). The theory treats human and non-human elements in a network on an equal basis without priory assumption about any of them. The research followed the suggested approach during the data collection. The concept of Translation in ANT is a key part of the theory. The study has used the concept to analyse and frame the findings. The following Table 1 provides a brief description of the key ANT concepts that has been used in this paper.

ANT Concept	Brief Description
Translation	This is the programme of action which is concerned with “how actors and organizations mobilize, juxtapose, and hold together the bits and pieces out of which they are composed” (Law, 1992, p.386).
Problematization	This is the first phase of Translation in which initial actors identify a problem and propose a possible solution. Then some of the initiators become ‘focal actor’ to represent the network and establish an Obligatory Passage Point or OPP (Callon, 1986).
Obligatory Passage Point (OPP)	OPP is a situation or process “that has to occur for all of the actors to be able to achieve their interests, as defined by the focal actor” (Sarker et al., 2006, p. 56)
Interessement	During the second phase, focal actors try to “convince other actors, whose interests are in line with the initiators’ interests, to join the network” (Tsohou et al., 2013, p. 41). Focal actors use various strategies to reach the Interessement goal (Wissink, 2013, p. 5).
Enrolment	The third phase of Translation process “involves a definition of roles of each of the actors in the newly created actor-network” (Mähring et al., 2004, p. 214).

Mobilisation	The final phase is to ensure that initiators are representing and supporting the enrolled masses (Postma, 2009). Initiators ensure that all the actors work together to maintain the problem-solution definition and keep other actors enrolled in the network (Vos, 2014).
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Table 1 Key ANT Concepts

4 RESEARCH DESIGN

This research has used a qualitative research methodology within an interpretive research paradigm and a case research method. Considering the three epistemological paradigms – positivist, interpretivist and critical – proposed by Orlikowski and Baroudi (1991), this research followed an interpretive epistemological paradigm. That was because the paradigm allowed the researcher “to understand phenomena through accessing the meanings that participants assign to them” (Orlikowski & Baroudi, 1991, p. 5). Similarly, the case research method was to easily accommodate contextual and specific organisational information (Myers, 1997). Since the Learning Exchange was a broad and relatively new phenomenon with insufficient body of related knowledge, case research method allowed to get an in-depth view and describe how the Learning Exchange clusters were participating in the programme.

Regarding the data collection and data analysis processes, individual cluster was the logical unit of analysis. The classification and selection of clusters were based on a number of criteria: the number of active member schools in a cluster; the number of courses offered by a cluster; the number of enrolled students in cluster; the nature of a cluster (receiving or offering courses or both); and, the operational level of a cluster. Based on these criteria, SchoolNet was selected as one of the clusters for data gathering. In-depth interview was used as the technique to collect data from individuals. Thirteen individuals were interviewed for around an hour each. In line with the theoretical foundations of ANT, inputs were gathered from non-human elements or ‘actants’. That was to consider the socio-technical approach proposed by the ANT. Therefore, related documents, such as policy guidelines, Memorandum of Understanding between schools and SchoolNet, user manuals and minutes of monthly intra-cluster meetings were collected, analysed and included in the reporting of the findings. In addition, as proposed by Luoma-aho and Paloviita (2010) and Vidgen and McMaster (1996), data *for* non-human elements were collected *from* their proxies. That was carried by asking questions from the staff regarding the role and effectiveness of ‘the things’, such as VC systems and other ICTs tools.

Based on the ethical agreement between the research interviewees and interviewer, recorded interviews were fully transcribed and sent back to the participants for checking if the transcriptions were correct. Nvivo software was used to seek help for organising and analysing the data. The four phases of Translation from ANT has been used to outline the findings in this paper. A summary of the initial findings was posted to the research participants for their review and confirmation. In most cases, they agreed with the findings and suggested some minor editions which have been addressed.

5 RESEARCH FINDINGS – TRANSLATING SCHOOLNET

5.1 Problematisation: identifying the problem and possible solution

Three main activities occur in this phase: initiators identify a problem that is relevant to other actors; propose a possible solution; and if successful, an Obligatory Passage Point or OPP is established by the focal actants (Figure 1) (Carroll et al., 2012; Callon, 1986). To identify the problem, SchoolNet initiators were asked to recall the time when they conceptualised SchoolNet and give some of the reasons why they needed to form a network of schools. They revealed that in the early 1990s, “small schools in rural New Zealand were unable to meet the growing educational demands of their secondary level students”. Those students wanted to have a variety of subject options, however their schools could not meet their needs due to the small number of students and limited resources. Consequently, a growing number of students were moving to urban and boarding schools, resulting in some schools having to close their senior secondary level. In addition, their specialised subject teachers had to consequently teach outside

their specialised areas and were “becoming gap-fillers”. As a result, a growing number of teachers were also leaving the schools. Thus, “the problem had become a matter of survival for their schools”.

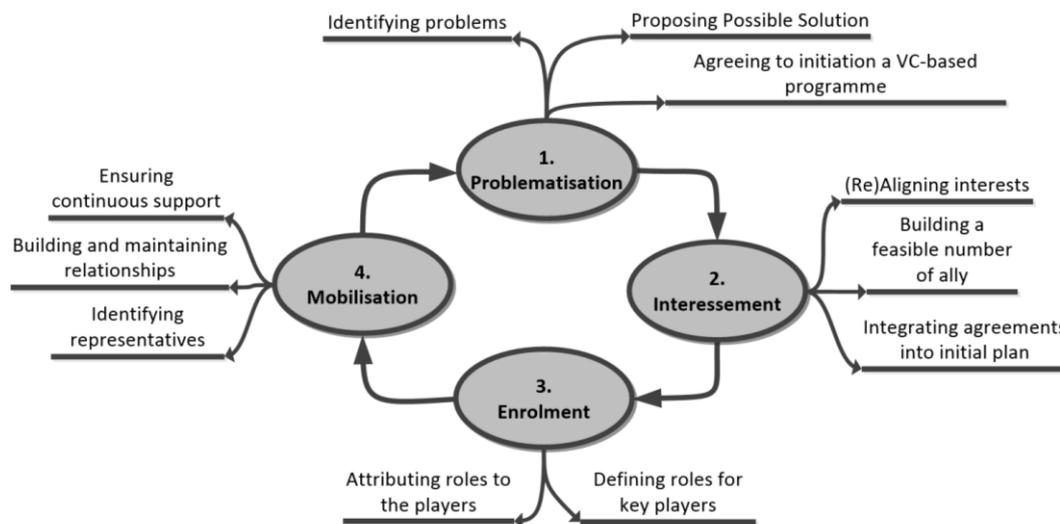


Figure 1: The process of Translation and SchoolNet

Regarding the causes of that problem, it appeared that multiple factors had played roles in that problem. The actors’ stories frequently revealed three main causes: demographic changes of the 90s, the students’ lack of satisfaction with The Correspondence School (TCS) and the limited financial resources. “Demographic changes in the 90s had a significant impact on schools” which was due to the depopulation of smaller towns in rural regions of New Zealand. On the other hand, TCS has historically remained the leading distance education programme for schools in New Zealand and around the world as a solution to similar problems. However, senior management actors in this study said that “we were using the Correspondence School but found...that wasn’t ideal; that filled the gap but wasn’t perfect and the kids...didn’t really like Correspondence that much”. The dissatisfaction of students with TCS partly contributed to that problem. Lastly, regarding the limited financial resources in small schools, the number of students in a school is one of the underlying factors based on which the New Zealand government allocates funds to schools. The findings revealed that due to the small number of students, financial resources at the schools were limited and thus they could not afford to assign a teacher to a specialised subject class with only a few student enrolments. Limited financial resources meant that the available teachers had to teach subjects outside of their specialised areas – becoming gap-fillers. On the other hand, the limitation had left students with a few subject options to choose from. As a result, schools were unable to retain their specialised subject teachers as well as senior students.

To give some context, while visiting some of the schools for data collection in June 2014, I travelled about 130 kilometres from the nearest airport to get to one of the schools. Schools in that area were around 40-50 km apart from each other. Furthermore, the total population of the town visited was close to only 600 people and the total number of students in that school was around 170, from Year 1 to Year 13. These facts further clarify the significance of the challenges faced by schools in those regions where resources are already limited and the population is spread out as compared to the urban areas.

To address the problem, seven or eight schools got together to find some solution to the problem. Three possible solutions were identified by the study: TCS, CASATech and SchoolNet. The above paragraphs described TCS as an existing, but unsatisfactory, solution during that time. The attempt at an alternate solution started in the early 90s when some Canterbury and Otago rural schools saw Internet-based telecommunication technologies as a potential actor necessary for resolving the problem. Those schools formed a network of neighbouring schools, called CASATech school cluster to enable those schools to wider subject choices and subsequently stop ‘betrayal’ of their actors (senior students and specialised subject teachers). Based on the stories of the research participants, the CASATech initiative underpins

two facts: the introduction of the virtual clustering or networking strategy, and the first formal use of Internet-based telecommunication technologies in a cluster of schools for distance education in New Zealand. They used a technological setting, called audio-graphic, which was described as, “a limited, two-way, communication system where participants needed two separate telephone lines – one for audio and another for graphics from their computer screen”. The setting was limited because participants could only see what was shared on the computer screen, and were unable to exchange learning materials or have any visual contact with a real person talking in those classes. The limitations literally made CASATech less interactive – failing to bond their enrolled actors and mobilise further allies. However, the effort of creating a network of schools did have some effect on the school community in that region.

A third solution for the problem was proposed in early 2000 by a group of seven or eight rural schools, called SchoolNet. The solution was built upon the CASATech experience. SchoolNet differed from CASATech on two fundamental grounds: using videoconference (VC) instead of audio-graphic technologies and following a reciprocal model as opposed to the subscription model. The proposed use of VC was not only to connect two or more sites at the same time but also to enable participants to speak and listen as well as watch a real person talking at the same time, capabilities that were missing in the audio-graphic solution. The second aspect of the new solution was the reciprocal or the exchange model. The new model was based upon the virtual exchange of existing human–teachers and students–and learning resources. In the exchange model, if a school had to receive a course, in return, they have to offer a teacher to teach a VC class based on the school’s capability and the availability of their teacher. On the other hand, the subscription model was built on the financial commitment in which schools (who were already small and financially struggling) had to pay for enrolling their students in CASATech. Therefore, the exchange model was agreed upon as the possible solution by all the seven schools.

After the successful problem-solution definition, another key aspect of the Problematisation is the establishment of an Obligatory Passage Point (OPP) for the alignment of interests by focal actors. Based on the individual stories, the research identified that seven or eight deputy principals were involved in the initial meetings. Two of them were active and knowledgeable; therefore the two actors became focal actors – known as cluster coordinators by the schools. The research found that the role was central to the existence of the network, therefore the role is regarded as indispensable and able to establish an OPP for others. The Enrolment process further elaborates the role of cluster coordinator.

During the Problematisation, the focal actors established the Learning Exchange model as the OPP through which every actor in the network had to pass. In order to exchange resources, schools had to be a member of the group to get their students enrolled in a class. Without signing up and being a member, schools were unable to benefit from the solution and see their interest aligned with the network. In addition, the VC-based class appeared as the key part of the OPP for schools, since they had to form the VC-based class in order to receive an online course. Without that new class structure, the formation of the network would not have existed in the way the focal actors had planned. For these classes, VC equipment was selected by the focal actors as the obvious tool capable of connecting and providing visual contact between students and teachers from the member schools. At the end of the Problematisation process, some questions arose. For example, did the focal actors succeed in convincing and recruiting actors necessary for the formation of an alliance? The Intersement Section provides answers for such questions.

5.2 Intersement: fettering together

The Intersement phase is use of various strategies by focal actors to convince potential players. Based on the individual stories and inputs from non-human actants, the research found that the focal actors had identified potential players necessary for building the network and persuaded them to play roles in the network development. The Local Community Trust, Ministry of Education (MOE), a polytechnic as well as neighbouring small schools were identified as the important actors required for achieving the goal set during the Problematisation. Without their participation, the process of Translation – the programme of action for the development of SchoolNet – would have been unsuccessful.

The study discovered that the focal actors had chosen to engage the Local Community Trust because they knew the Trust had the agenda for supporting local community and schools in the region. The Community Trust was persuaded who financed schools to buy VC equipment. Through the patronage of the Trust, Telecom New Zealand was approached to negotiate for developing a special broadband Internet package for member schools. Third party organisations, such as some polytechnics and a local university, were enrolled to offer agriculture and other courses that were not generally taught at schools. In return, the Polytechnic saw their interests aligned in the network because their participation in the programme was perceived to increase their student enrolments. This scenario indicates a direct effect of SchoolNet on another actor-network. Importantly, other neighbouring schools who were not involved in the initiation process were persuaded to become part of the network. That was necessary to have a sufficient number and a variety of courses available for member schools to exchange so that their interests can continuously be aligned in the network. These events indicate a successful Interesement, since without their recruitment Translation could not have moved to its next phase – the Enrolment.

The focal actors had also foreseen that the support of the MOE would be crucial for building the network, therefore the initiators had decided to intensely ‘lobby’ the Ministry. Although initially during the Problematisation the MOE had stepped back, this time the focal actors had endeavoured to engage the Ministry in the programme through personal channels. As a result, the MOE agreed to support the programme by covering the cost of building a VC bridge for connecting different schools. Later, the Ministry had also hired a third party technical help desk for supporting the cluster schools to deal with technical issues related to VC equipment. In 2008, MOE funded the cluster for two years to cover operational costs and strengthen the cluster leadership. However, not all initiators were satisfied with the level of MOE support. Some considered instead of having an active role, the MOE had chosen a passive role, making the MOE a little controversial in the network. On the other hand, some initiators had a different view regarding the MOE’s role and its level of support for the programme. As one initiator noted that “Innovation sometimes has to come from schools themselves and then the Ministry will come along later when they think that something looks really useful, then they will come and put their support in”. That is perhaps one of the biggest factors that have supported SchoolNet to develop as a self-sustaining cluster without heavily relying on external actors.

5.3 Enrolment: defining roles and responsibilities

According to the individual accounts of the events, the initiators formed a new association – the SchoolNet cluster of schools – in early 2002 with 11 online classes. The new association remained different from the actors’ original associations (schools). Students, teachers and other actors still remained part of their mother organisations, but at the same time, they became members of the SchoolNet association too. Therefore, the initiators had defined various roles (see figure 1) including cluster coordinator or e-principal, member school, e-dean, e-teacher and e-student.

The role of a cluster coordinator or e-principal was defined as having responsibility for overseeing ongoing cluster activities and remaining in continuous contact with different actors in the member schools. Overseeing activities meant that a cluster coordinator was responsible for working with e-deans (or lead teachers) from each member school to organise teachers, enrolling students and managing the VC-based courses before the start of every school year. During the year, the coordinator was assigned the responsibility of managing the smooth running of those courses by being in continuous contact with member schools via online means as well as by having physical visits to each of the member schools. Therefore, the cluster coordinator role was found to be central in the management of the network, continuously attempting to (re)build and maintain links and relations between different actors in the network. That also rationalises coordinators as the focal actors representing and leading the network.

Since the role of cluster coordinator was the node at a central position in the network, concerns were raised regarding the risk of network destabilisation due to the concentration of power at a single point. When I asked, “What if a cluster coordinator who manages all the contacts and links all the relationships decides to leave for another role outside this network”? The response explained the initial actors had

“deliberately tried to have a distributed team of leadership”. The response also indicated the awareness and anticipation of the initiators regarding the risks associated with the leadership role.

The role of member schools was created for participating schools and were delegated three tasks. First, each member was responsible for having a minor reform of their management hierarchy by creating an e-dean role and dedicating an actor to perform the role. This was significantly important for the mobilisation of the enrolled e-students and e-teachers in the network. Second, each school was to make a financial contribution for covering coordinator’s salary and operational costs of the cluster. This was found as another significant factor for developing SchoolNet as a financially self-sustaining cluster. Finally, each member school was to provide at least one VC class teacher based on the network’s need and the school’s capacity. The three commitments were delegated to schools as they joined the network.

Within the member school, the e-dean role was established to support e-student and e-teachers in the member schools, maintaining their Mobilisation in the network. Based on the actors’ stories, e-dean was recognised as the dedicated actor in the network for continuously supporting micro level actors, e-students and e-teachers within their schools. E-dean was also the primary point of contact for the cluster coordinators as well as other member schools. From the theoretical lens, e-dean was the focal actor representing the network in the local school at micro level, holding together the links micro level actors by continuously (re)aligning their interests within the network. Additionally, e-dean was responsible for enrolling new actors (e-students and e-teachers) every year by identifying their problems, and aligning their interests in the VC classes. Therefore, the e-dean role was identified as being as significant for schools as the role of cluster coordinator was for the whole network. In other words, e-dean was another powerful role that involved continuously (re)creating links and relations in the network at micro level. One of the e-deans reported the role as being a “conjure” assisting and preparing students for a different learning environment at tertiary level as self-paced learners.

The e-teacher was a role with the task to prepare and deliver a one-hour long VC-based class every week. With the use of Internet-based videoconferencing technologies, e-teachers conducted those classes with a maximum number of 14 e-students from up to seven different schools. In addition, every e-teacher was allotted a separate three indirect contact hours per class every week (making altogether four hours per week for a VC class). The three indirect hours were basically for preparing lessons and responding to student emails in order to help students comprehend their lessons. Most importantly, those three hours were for building teacher-student relationship in the virtual environment. Therefore, the focal actors had set three indirect hours as a standard and member schools were recommended to follow that standard to balance the workload. However, despite the clear definition of the standard, some schools were not meeting their commitment, causing some e-teachers to leave the network and making the school less active with fewer students and courses in the network. For example, some e-teachers were allocated only one indirect contact hour by their schools. That was because their schools leaders perceived one indirect contact hour as sufficient for e-teachers activities outside VC classes. Therefore, the weak perception was a problem, undermining the enrolment of new e-teachers and indicating the importance of commitment and support from the school senior leadership team.

Within the member schools, e-student was the role assigned to the actors interested in receiving VC courses based on their individual needs as well as skills and interests. The actors were responsible for their own learning and managing their study independently. The enrolment of e-students started at the end of every year by their local schools. E-students were required to attend a one-hour VC class every week and manage their self-study hours independently. If e-students encountered problems regarding the course content, they had to contact their e-teachers as the first port of call. For managing and resolving technical issues and administration activities, their e-dean was the actor responsible.

The study identified parents as another important, however ‘black-boxed’, actor closely associated with e-student actors. According to Vos (2014), black-boxes are parts of a network that are “considered no longer interesting, or where they are simply accepted as they stand, are thought to be reliable and unchanging” (p.61). Parents were found to have an influencing role on e-students not only during their Interessement and Enrolment but also during their ‘Mobilisation’ (next phase) in the network. However,

member schools, e-deans and cluster coordinator were found to have overlooked formally enrolling parents in the network. Although parents are generally involved in schools' boards of trustees, SchoolNet remains a separate association. The lack of such promotion posed a challenge for some e-students in maintaining their Enrolment in the network or meeting their responsibilities as self-managed and independent learners. This was because e-students required parental support to maintain their link in the network. The absence of parental understanding and support posed a challenge to the Mobilisation of the actors too. Therefore, the e-student role in member schools was a weak node in the network and the challenge remained a factor that can destabilise the network, particularly when the whole network is assembled with a 'student-centred' approach and built for integrating geographically isolated students.

Videoconferencing (VC) equipment and other non-human actors – the things – were brought into the network for the exchange of learning resources and to facilitate communication between geographically isolated participants. While speaking with the things, the four questions discussed by Thompson and Adams (2013) were discussed with their *proxies* (discussed in section 4). SchoolNet initiators had recognised telecommunication technologies as potential actors with problem-solving capabilities, if employed accordingly. Based on that understanding, participants specified that the usage purpose of the VC equipment was a good match with the interest of SchoolNet. As a result, VC was enrolled in the network as the actor responsible for providing a platform for conducting online classes. The VC equipment includes a set of TV screen, video camera, document camera and microphone, and is connected to the Internet. More recently, other non-human elements have been enrolled in the network, which include computers, laptops, mobile devices and Internet-based applications (such as email, Skype, Facebook, Google Applications and so on). During the situations where VC had failed to perform its tasks, e-students were calling their e-deans and ringing technical helpdesk (ASNet) to make the technology work. Those situations of social ties – calling the e-dean, ringing ASNet and resetting the VC equipment – were the 'movements of modification' caused by 'the things'. Therefore, this research considered every actor relevant for the network and assessed their effects on SchoolNet. With the role of technologies, no significant issue or challenge was raised, indicating towards the reliable and effective use of telecommunication technologies as another factor for the sustainability of a cluster.

5.4 Mobilisation: supporting participants

The findings revealed building relationships and providing continuous support by the focal actants as the two important interrelated factors underpinning the network's sustainability.

Organic Relationship: According to Tatnall and Gilding (1999), "a network becomes durable partly due to the durability of the bonds that hold it together, but also because it is itself composed of a number of durable and simplified networks" (p. 959). This means that a network can be durable if relations between and within different elements of that network are strong. For example, the durability or stability of SchoolNet would depend on how good relationships are between different actors at the cluster level, and how good those relationships between those cluster actors are within their corresponding schools. In other words, the stability of a network depends on the strength of relationship both at the micro and macro levels. The role of the cluster coordinator discussed in the above section answers the question regarding building relationships at all levels. However, maintaining that relationship was a different challenge that could undermine the network's stability, if neglected. The findings revealed that the cluster coordinator and some of the e-deans had not only built but also maintained that relationship at a 'personal' level and by "developing a sense of community and ownership rather than a service-client type relationship". This is because, the SchoolNet "programme is more about learning communities, about learning relationships between students and students, and students and teachers".

Continuous Support: Providing continuous support was identified as another significant factor that had successfully mobilised actors from member schools. Arranging monthly meetings between schools and e-teachers was important for continuous support from the focal actors. Specifically, 'e-day' and 'e-hui' were the annual formal gatherings that promoted continuous support as well as developing relationships with newly enrolled actors, and (re)building and maintaining that relationship with the existing ones.

E-day was recognised as the e-students' and e-teachers' annual gathering, held once at the start of every year to provide an opportunity for the actors to meet each other face-to-face before the start of their VC classes. This was a major act of mobilisation – ensuring continuous support. Most importantly, the e-day was an act of building trust and relationships. However, the identified challenge was that not all actors in the SchoolNet school network had prioritised to attend annual e-days. That indicated varying interests or priorities between member schools and the focal actors. The focal actors considered e-day essential for the Mobilisation of the actors, because e-teachers and e-students always need continuous support to maintain their links and continue their relations in the network. However, senior management in member schools were not as interested to fulfil their agreed obligations. On the other side, e-deans were unable to convince or were failing to develop enough 'interest' in their senior management for supporting school participation in the Mobilisation activities.

Similarly, e-hui was noted as the professional learning development (PLD) workshop held once at the end of every year, in which experienced e-teachers shared their experiences with e-teachers newly enrolled in the network. The sharing of experience was a kind of self-managed professional development workshop provided by the focal actors to support e-teachers. In addition, the event was an opportunity for e-teachers to meet other e-teachers of similar subjects to exchange class resources.

Although the PLD seemed to be an excellent effort, most of the e-students interviewed expressed concerns with their e-teachers' teaching styles in an online environment. Some of the e-teachers were reported to replicate their face-to-face class strategies during VC classes, and others even as not having any strategy at all. One of the e-students with four years of VC experience responded that over the years many things had changed except the learning and teaching. Another e-student described different teaching strategies in VC where one e-teacher was referred to as "just throwing information" while another e-teacher was regarded as "engaging students by asking questions". One e-student with 3 years of VC experience and having taken eight VC-based subjects expressed frustration with one of her VC classes and regarded that class as a "train wreck" and the e-teacher as "very disorganised", and recommended a "lesson plan". Another e-student clearly suggested more professional.

The e-students' dissatisfaction towards e-teachers' delegated obligations not only indicated how critical the e-hui was for the Mobilisation of e-teachers but also questioned the number of PLD opportunities particularly focused on e-teachers' needs. These dissatisfied e-student actors could betray and leave the network after their failed Mobilisation experiences, and hinder the Interestment of prospective e-student actors. Therefore, the absence of a personalised PLD programme for e-teachers was one of the factors that could affect the stability of the SchoolNet school network. In particular, the MOE's active role in helping to manage PLD programmes tailored for e-teachers remained very important for mitigating the issue. Therefore, the focal actors needed to redefine the continuous support required for the Mobilisation of e-teachers and subsequently realigning the network's interests with the e-students' interests. For that, the MOE's role needed to be redefined with the responsibility of actively supporting tailored PLD programmes for e-teachers.

Top Management Support: In the development of schools' priorities, schools' senior management, particularly principals, are responsible for setting their organisational priorities. How schools' leadership perceive VC activities or online teaching and learning influence their contribution to such activities. Therefore, the leadership perception was a driving force for some but a barrier for other schools to their virtual activities. That fact was more evident after a change of leadership in member schools. There was either a significant increase or decrease with a change of school leadership – particularly the principal. Regarding the schools' senior management support, one of the e-deans actively participating in the network said, "I don't think we would be anywhere near the stage with e-learning without that support...if you don't have that senior management support, it would be a very hard battle to fight on your own. I am lucky because I straddled both the senior management and our department in here".

Deep Local Support: The type of support meant how well member schools supported their e-students locally. During the Enrolment, member schools and e-deans were delegated the task of supporting their e-students at their own school level. E-teachers was responsible for the teaching and learning processes

whereas deep local support from schools was basically intended to assist e-students to cope in the new environment and during the transitional process – from being teacher-led learners to self-managed independent learners. The support was significant for helping e-students to maintain their relationships with their e-teachers and e-fellows and remain enrolled in the network. To clarify the nature of the support, an initial actor responded that, “the other thing which makes a difference to whether it [the programme] works or doesn’t work for learners is how well the schools themselves get around and support the students, not in a teaching way but in a pastoral way”. One of the schools’ senior management actors regarded the provision of such support as one of the factors for e-students’ success in the online space. This is because some of the e-students might be experiencing the environment for the first time or not have much experience of being independent learners. They need some mediating elements for that modification and indeed the deep local support is one of the main elements.

Challenges were found regarding the provision of local support, a task promised to be undertaken by the member schools. Some schools within the SchoolNet had set up multiple layers of support around their e-students, whereas other schools had left their e-students on their own. In one school the e-students had four layers of support, both in teaching as well as pastoral ways: First, the schools had an active e-dean with many support roles such as administrator (student enrolment and photocopying and printing materials), technical assistant (resolving technical issues by herself as well as by ASNet), mediator (contacting and reminding e-teachers to respond to e-students’ emails if not responded to within 48 hours), examiner and so on. Secondly, pair and peer learning strategies were placed around e-students in the schools by grouping e-students from the same or different levels. That was to provide collegial support. The third layer of support was a mentoring scheme in which each e-student was provided with a mentor who was a teacher in that school from a similar subject area, if not from the same subject. For example, a calculus subject teacher was a mentor for 2-3 e-students taking mathematics classes over VC. This was so e-students could have access to a local teacher for any quick query. Finally, the school had a one-week long e-learning module at the start of every year for their e-students. The short module aimed to train e-students to cope in an online environment which remained very different from their face-to-face class environment. In particular, that module was helpful in supporting the transition of e-students from being purely instructor-led learners to independent and self-managed learners.

In addition, the findings revealed that such deep local support had helped in building and maintaining student-teacher relationships by keeping both the parties informed and in continuous contact. Without that support, student-teacher relationships were quite weak and students had experienced many issues, such as: lack of engagement or feeling bored during VC classes; lack of student-student interaction; difficulty in becoming independent learners; poor student-teacher relationship; lack of trust or feeling shy during VC class; getting late email responses from e-teachers; uncovered course content; an uncomfortable or damp VC room; having frequent technological issues; and not feeling confident in using different technological tools available in the VC room. One of the focal actors agreed there were problems with e-students in a few SchoolNet cluster schools and nominated poor support as a barrier and the reason for most of the problems, “Because a student in a VC class has one hour direct contact and three indirect contact hours, depending on how well schools provide that support is probably the single biggest factor to whether the initial first experience of an online student is successful for them or not or highly successful. That poor support is a barrier”.

6 DISCUSSION

6.1 Key Influencing Factors

ANT attempts to identify controversies in a network and make connections between those controversies to explain ‘how something happens’ rather than attempting to solve and justify ‘why that happened’ (Law, 1992). For that reason this study attempted to identify controversies and their links in SchoolNet, aiming to achieve the two research objectives outlined in the Introduction Section. For that identification, the four phases of Translation were used to interpret the development of the school

network. Those links were labelled as the factors that can (de)stabilise the school network. Table 2 outlines key features that have supported SchoolNet to develop as a self-sustaining cluster.

Features	Significance	Supporting factors
Common agreement over the problem and solution, or aggregated goal	High	<ul style="list-style-type: none"> • Common vision • Shared interest • Successful (re)alignment of interests with the changing needs of participants
Successful identification and engagement of key players	High	<ul style="list-style-type: none"> • Having strategies for engagement • Leveraging cluster's potentials
Dedicated coordinator	High	<ul style="list-style-type: none"> • Strong cluster leadership
Positive role play by member schools/players	High	<ul style="list-style-type: none"> • Strong school and cluster leadership • Having strategies for self-sustainability
Financial contribution by member schools	High	<ul style="list-style-type: none"> • Dedicated members • Having strategies for financial self-sustainability
Proactive e-dean	High	<ul style="list-style-type: none"> • Provision of deep local support
Reliable technology		<ul style="list-style-type: none"> • Having reliable technology • Effective use of technology
Supportive group of principals	High	<ul style="list-style-type: none"> • Support from school senior leadership
Continuous support for enrolled masses	High	<ul style="list-style-type: none"> • Strong relationships • Satisfied participants

Table 2. Supporting Factors

Table 3 provides a list of challenges that existed in some of the SchoolNet schools and could cause destabilisation in the network. However, such schools were outnumbered by the schools with a very proactive team of senior management and e-deans. Most importantly, SchoolNet had their cluster coordinator holding together all the actors out of which they were composed. For example, from the theoretical perspective, it is important to note that every school by itself is an actor-network where not only e-actors but also face-to-face (F2F) actors come into play. In that network, F2F teachers were found as the hostile actors opposing VC classes, since they felt affected and annoyed, and sometimes threatened by the growing number of students joining VC classes. One of the participated reported, "Because you are dealing with human and probably one of the biggest constraints are human attitude and some beliefs". The opposition was one of the significant factors capable of sabotaging the role of member schools and consequently the network stability. The hostile attitude can disrupt any member school's contribution in the network if the problem was treated as insignificant. However, member schools studied in this research were successful in countering the opposition by having some strategy to deal with the issue. Therefore, the positive role played by the school's senior management remained a significant factor for the network's development and sustainability.

Challenges	Significance	Inhibiting factors
MOE's passive support	Low	<ul style="list-style-type: none"> • Lack of active support from external players
F2F teaching staff feeling threatened	Low-Mild	<ul style="list-style-type: none"> • Negative human attitude and beliefs • Technology being a disruptive tool
Allocation of fewer hours for teaching a VC subject	Mild	<ul style="list-style-type: none"> • Lack of commitment from school senior management • Weak perception of school leaders about online education
The absence of parent's role	Mild	<ul style="list-style-type: none"> • Lack of parental support for e-students in the online space
The absence of some member schools in e-days	Mild	<ul style="list-style-type: none"> • Difference of priorities between member schools • Lack of commitment from member schools
Dissatisfied e-students with their e-teachers	Mild	<ul style="list-style-type: none"> • Need for effective PLD for online teaching

Table 3. Identified Challenges

In addition, since SchoolNet was one of the Learning Exchange clusters that has successfully established itself as a self-sustaining cluster, most of the challenges were of low to mild significance. That was because of the above features that had supported the cluster leadership and member schools to develop such a cluster. Failing to embrace the above features could not only turn those features into challenges but also increase their significant and impact for a cluster. Consequently, the cluster could be relegated to a destabilised position and then disappear from the scene.

6.2 Implications

By identifying the supporting and inhibiting factors, the study brings up practical implications for the eight existing Learning Exchange clusters, including SchoolNet. The Learning Exchange has enabled schools in rural communities to participate in collaborative learning. Therefore, by addressing the programme through the research objective, on one hand, this study has attempted to answer the problem of school clusters' shrinkage from 18 clusters to 8. On the other hand, this research particularly remains significant for the existing clusters to embrace the features of SchoolNet and avoid from any destabilisation in future. Further, the research remains important for other groups of rural schools in the developed countries needing to address similar problems. Thus, the practical implications are not limited to the context of New Zealand but also for rural schools in other developed countries and regions.

Moreover, since the model has become an example for changing school's paradigms, from 'Connected' to 'Networked school', the rest of the schools in New Zealand can learn how to switch their F2F classes to an e-class. That remains another major practical implication of this study.

The theoretical value of this study is the theorisation of the Learning Exchange clusters. Some other studies have attempted to address the clusters, however they have not researched the area with a theoretical approach. Therefore, this study extends the use of ANT to the study of a virtual community of educators. In addition, by identifying the facilitating and inhibiting factors for the development of a sustainable cluster, this study indirectly explains 'why' some clusters successfully maintain themselves while others struggle to stabilise. By doing so, this research disputes Law's (2009) justification of the ANT as an approach not a theory. Since Law (2009) argues that a theory usually 'explains why' something happens, whereas ANT 'describes how' things relate or do not relate.

With regard to the connection of the paper with the field of IS education, the study remains relevant in many ways. For example, the networked school approach is relevant as it merges the traditional school systems and distance education. Moreover, the adoption of virtual clustering approach for collaborative and reciprocal exchange of learning in schools while utilisation various synchronous and asynchronous tools is another example of the relevance of the paper with IS education.

6.3 Limitations

Although SchoolNet is the pioneer cluster of the Learning Exchange, the study is limited to one of the successful clusters only. Some other Learning Exchange clusters have also made significant contributions to the programme, however due to the limitations of this submission, their findings have been excluded from this paper. Further, this paper also does not include the details of the clusters that have disappeared or been dismantled. These details could have made this paper more insightful.

7 CONCLUSION

We have studied how a small number of rural schools, faced with shared problems and finite resources, could group together and use ICTs collaboratively. The study examined virtual collaboration from its initiation and development through to exploring how the group evolved into a self-sustaining cluster. In doing so, a number of supporting and inhibiting factors were exposed to explain the development of such a cluster. The implications of these factors have practical consequences for both existing, as well as prospective, virtual clusters in the New Zealand setting. While our conclusions are restricted to the New Zealand context, the learning is potentially applicable in educational settings worldwide.

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