Using students' participation data to understand their impact on students' course outcomes

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Shadi Esnaashari

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Abstract

Many students with diverse needs are enrolled in university courses. Not all these students are able to be successful in completing their courses. Faculty members are keen to identify these students who have the risk of failing their courses early enough to help them by providing timely feedback so that students can meet the requirements of their courses. There are many studies using educational data mining algorithms which aim to identify at risk students by predicting students' course outcomes, for example, from their forum activities, content requests, and time spent online. This study addresses this issue by clustering the students' course outcomes using students' class participation data which can be obtained from various online education technological solutions. Using data mining in educational systems as an analytical tool offers researchers new opportunities to trace students' digital footprints in various course related activities and analyse students' traced data to help the students in their learning processes and teachers in their educational practices. In this study the focus is not only on finding at risk students but also in using data for improving learning process and supporting personalized learning. In-class participation data was collected through audience participation tools, the out-of-class participation data was collected from Stream and combined with the qualitative and quantitative data from questionnaires. The participation data were collected from 5 different courses in the mainstream university programs. Our first aim was to understand the perception of students regarding the effect of participation and using the audience participation tools in class and their effects on students' learning processes. Moreover, we would like to identify to what extents their perceptions match with their final course outcomes. Therefore, the tool has been used in different mainstream courses from different departments. The results of our study show that students who participated more and thought that the tool helped them to learn, engaged and increased their interest in the course more, and eventually achieved highest scores. This finding supports the view that in-class participation is critical to learning and academic success.

Produced Publications and Presentations

1. Shadi Esnaashari, “Bridging learning analytics with Xorro-Q: An institutional dashboard” (full paper-New Zealand Computer Science Research Student Conference NZCSRC. 2016).

2. Shadi Esnaashari & Anuradha Mathrani, Paul Watters, P. (2015)”Investigation of Audience Interaction Tools from the Perspective of Activity Theory”. 26th Australasian Conference on Information Systems. : The 25th Australasian Conference on Information Systems.

3. Shadi Esnaashari,” Is Participatory Pedagogy Useful and Satisfying for Tertiary Students?”, In submission.

4. Shadi Esnaashari,” Clustering Students based on their participation in classes”, In submission.

5. Shadi Esnaashari, “Bridging learning analytics with Xorro-Q: An institutional dashboard”, (ACIS Doctoral consortium), Adelaide, 2015.

6. Shadi Esnaashari, “Bridging Learning Analytics with Xorro-Q: An Institutional Dashboard for Engagement”, NZ Information Systems Doctoral Conference, NZISDC 2015.

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I was also lucky to have my husband, Ben, beside me during this time. He was my support all through my studies. I would also like to offer my special thanks to my parents for always supporting me and making this course of study possible in the first place.

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Chapter 1

Introduction

The importance of participation in classes has been emphasized by scholars. It is often argued that students need to participate in group activities in class in order to learn more (Aguiar, Ambrose, Chawla, Goodrich, & Brockman, 2014; Chickering & Gamson, 1987; Dearn, 1996; Kober, 2015; McConnell, 1996; Sibley & Spiridonoff, 2010; Singer & Smith, 2013) The importance and effect of interaction (Chickering & Gamson, 1987; Fulford & Zhang, 1993; Kearsley, 1995; Kumari, 2001; Stubbs, Bernstein, & Labor, 1976) and especially computer mediated interaction (Dawson, 2008) on education also have been emphasized in the literature. Different technologies have been used by researchers in classroom environments to improve the participation of students and improve learning (Park & Farag, 2015; Ravishankar, Epps, Ladouceur, Eaton, & Ambikairajah, 2014a, 2014b).

This study uses an audience participation tool (i.e. Xorro-Q) to enable anonymous interaction between students and the lecturer to see how the participation of students in classes can increase and how it is related to their course outcome. We want to understand students' perceptions in regards to using such technologies in classes to extend synchronous participation in classrooms and improve the overall teaching and learning experience.

There are different studies in the literature which used the data only from learning management systems in order to identify at risk students (Campbell, 2007; Goldstein & Katz, 2005; Hecking, Ziebarth, & Hoop, 2014; Kearsley, 1995; Wang & Newlin, 2002; Wang, Newlin, & Tucker, 2001); (Ayers & Junker, 2006; Chen, Liu, Ou, & Liu, 2000; Cocea & Weibelzahl, 2006; Grudnitski, 1997; Hämäläinen & Vinni, 2006; Kotsiantis & Pintelas, 2005; Minaei-Bidgoli & Punch, 2003; Pistilli & Arnold, 2010; Pokay & Blumenfeld, 1990; Ransdell, 2001; Talavera & Gaudioso, 2004; Ting & Man, 2001) But these systems have a lack of collecting data from in class activities and students' participation. By in-class participation, we mean how students participate in the activities run by their class teacher. We focused on the participation and learning of students within different courses with different teaching pedagogies from different disciplines.

Xorro-Q tool has been used in different disciplines such as Information Technology, Marketing, and Construction in a New Zealand university and helped us to collect in class participation of the students in order to find out about students' learning. At the end of the classes, a questionnaire was run in classes in order to understand the perception of the students regarding using the tool in classes. The

questionnaires have been given in Appendix 1. Based on the data from Stream, Xorro-Q, and questionnaires applying educational data mining algorithms we are not only making predictions about the course outcome but also investigate the learning process of students using learning theories of activity and self-regulated learning. Therefore, students' data have been mapped with their course outcome in order to find out how the data from students' course outcome are compatible with the students' perceptions of usefulness of the tool. The results showed that students who participated more and thought that the tool helped them to learn, engaged and increased their interest in the course more, and eventually achieved the highest scores. This finding supports the view that in-class participation is critical to learning and academic success.

1.1 Research questions

In this research, whenever students engage with audience participation tool in their classes, their digital foot print data have been collected through the tool. The data are analysed using the lens of activity theory to investigate the role of the tool acting as a mediator for the students to achieve their goals. The focus on the two elements of subject and tool in activity theory is to see how the tool is used to self-regulate the learning of students. The goal is to understand how using the tool affects participation of students in their classes and consequently their course outcome. When students' participation data are collected by the tools, clustering analysis has been used to understand whether the data collected through audience participation tool and Stream can predict the course outcome of the students.

The following research questions guided this study:

- What is the perception of students regrading using the tool in class and whether students believe that participation is helpful for their learning?
- How does weekly participation data of students' class activities help us to cluster the students based on their course outcome?

1.2 Ethical

For our research, following HEC guidelines, approval has been got from Massey University's Human Ethics Committee. Full Human Ethics approval number for the research is MUHECN15/046.

The benefit of this research for the students', lecturers, and the university has been explained. The process of collecting data, approaching the participants, and analysing the data have been deeply explained. In Appendix 2 we have provided the application forms for getting human ethics and in what follows a summary of the ethical concerns that we identified and explained to the HEC committee is given.

We explained to the HEC committee that we had initial discussions with supervisors and other stakeholders within the University about obtaining informed consent from the participants and also trying to identify potential harms or adverse consequences from undertaking the study in the format planned. We also undertook a risk assessment to determine the likelihood and impact of any adverse events, e.g. the likelihood of reverse identification of anonymized participant records, and still felt that answering the research questions for the greater good, to the best of my knowledge, outweighed the potential harms to individuals.

We also submitted our research plan and gave a presentation to the NZ Information Systems Doctoral Consortium (NZISDC) and Australian Conference on Information System Doctoral Consortium (ACIS-DC) attended by leading professors in our discipline. They provided feedback to us on issues surrounding experimental design and ethics. We also reviewed the methodology section of the relevant papers to our own study which are published in reputable journals. Then, drawing on them, we addressed the areas of possible concern in this study.

We need to collect and analysed the students' personal data which could not be the interest of the users. We will give information sheet to the students before start to collecting their data for the study and sought for their consents. If they agree to participate, we use their data. We make them sure that we will use high level of anonymity to maintain the privacy of the data.

We are analysing the learning path of the students but personal data which could expose the identity of the student will not be used. We asked the teacher to use the ID code for students to use in Xorro_Q. Also for the students' final score we will get the scores from the consent teacher by the students' ID codes.

When the researcher interview the students the identity of the student will be clear for the interviewee, pseudonym will be used to maintain the privacy of the user. The researcher will omit any

student's information which could effects on reverse identifying of the student (For example if just one person got a specific score, this could help to identify the student, so this information will be deleted).

We also know that students are very stressful about their grades, therefore we are not asking anything from students regarding their grades in order to prevent giving stress to the students. Consulting with teaching policy this is something that we avoid. We just like to help the students and we want to see all the students successful. Therefore, we avoid anything that gives stress to the students and affect their performance.

We also omit the name of the teacher. No information will be exposed to the reader which could lead to identifying learners and their teachers. We also will inform the Teaching and learning support, if the results of analysis show that the tool was helpful so that they can recommend the tool to the lecturer. In this way, other students and our control group was not disadvantaged from that.

1.3 Limitation of the study

The following limitations have been identified the in this study. First, we consider course outcome as a single final score. However, course outcome could be a result of combination of students' tests, written assignments, projects and satisfaction survey. Stanley and Hopkins (1972) identified 50 factors which reduce the reliability of final scores. However, for the purposes of this study a single final score has been considered as the course outcome.

Second course outcome can also be affected by different parameters. It could be student learning style, background, teacher's style of teaching, and difficulty of exam. We are interested to consider the participation of students and their changing patterns during the course of study on their course outcome.

In addition, when we intend to consider identifying the students who are at risk of failure, there can be a variety of reasons for students dropping out such as financial problems and performance. This study is limited to making prediction based on participation of students in the course.

1.4 Benefits of this research

This study is expected to benefit to lecturers, students, and academic institutions.

Lecturers can reflect on their own teaching while using the tool in their classes. In addition, lecturers can have access to students' participation patterns and could take the necessary measures from early on in the course. They can provide more supports to students who need it.

The institution can identify at risk students more easily and help them with their possible problems. In New Zealand universities are financially penalised if more than 30% of students fail a paper. Therefore, identifying the students who are at risk of failure will provide an opportunity for the university to help the students to prevent them from failing.

Students can have access to their participation history in the class and can compare themselves with anonymous peers. This can help them to choose better strategies for their learning.

The study will shed light on the learning process of the students which could help learning scientists. This has implications for further development of innovative learning pedagogies, assessment models and design tools to support student-centred learning.

1.5 Thesis structure

Here are the research questions:

- Q1: What is the perception of students regrading using the tool in class and whether students believe that participation is helpful for their learning?
- Q2: How does weekly participation data of students' class activities help us to cluster the students based on their course outcome?

In order to address the above questions, we have organised the thesis as follows:

We use Chapter 2 to address Q1 by presenting our paper called "Investigation of Audience Interaction Tools from the Perspective of Activity Theory". This chapter suggests using a real-time audience engagement solution (Xorro-Q) to facilitate synchronous interaction between lecturers and their student audiences. Using activity theory as a theoretical framework we conducted a study to

investigate student participation and engagement with an audience interaction tool in two undergraduate computing courses. However, there are a few limitations in this study. For example, the study has been conducted in the second half of the teaching semester. Also, the low attendance and low response to the final survey tool are other limitations of this study.

It would have been better if we could have run the test from the beginning of the course to the end and put students under focus from the start to understand how their level of engagement changed during the course. Also, since we did not have human ethics approval at the time when we run Study 1, we could not have access to the final course outcome of the students. Therefore, we ran our second study which has been presented in Chapter 3 and Chapter 4.

Chapter 3 presents the paper entitled "Is Participatory Pedagogy Useful and Satisfying for Tertiary Students?" In this chapter, we answered Q1 but this time with students' data from the whole semester i.e. 12 weeks of using the tool in their classes compared to our first study in which we were able to run the tool in just second half of the course. We endeavoured to understand whether a more participatory learning approach might be perceived as more useful and satisfying for tertiary students in New Zealand. The results indicate that students are willing and motivated to engage in new approaches to learning and teaching in the classroom. Chapter 4 presents the paper called "Clustering Students based on their participation in classes". In this chapter, we answered our second research question. We combined in-class and out-of-class (e.g., Learning Management System) data with a range of qualitative and quantitative self-report measures. We used K-Mean data mining algorithms to cluster students based on their participation in the class and we found that students who participated more and thought that the tool helped them to learn, engaged and increased their interest in the course more, and eventually achieved the highest scores. This finding supports the view that in-class participation is critical to learning and academic success. Finally, Chapter 5 presents our discussion and conclusion. We also provide future work for further research.

Chapter 2

Investigation of Audience Interaction Tools from the Perspective of Activity Theory

Shadi Esnaashari

School of Engineering and Advanced Technology

Massey University

Auckland, New Zealand

Email: S.Esnaasahri@massey.ac.nz

Anuradha Mathrani

School of Engineering and Advanced Technology

Massey University

Auckland, New Zealand

Email: A.S.Mathrani@massey.ac.nz

Paul Watters

School of Engineering and Advanced Technology

Massey University

Auckland, New Zealand

Email: P.A.Watters@massey.ac.nz

Abstract

Maintaining engagement of large audiences is not easy. Traditionally, lectures and presentations have relied on one-way communication from the presenter to the listening audience. Without receiving ongoing feedback, speakers cannot be sure that their delivery is at an appropriate pace, or that their message is being received and understood by their audience. This study suggests using a real-time audience engagement solution (Xorro-Q) to facilitate synchronous interaction between lecturers and their student audiences. Using activity theory as a theoretical framework we conducted a study to investigate student participation and engagement with an audience interaction tool in two undergraduate computing courses. In one classroom setting, the lecturer employed continuous informal discussion-based teaching activities with Xorro-Q tool. The other classroom setting used Xorro-Q to formally assess students' subject knowledge by using traditional quiz type questions. The preliminary findings showed that audience participation tool has a promising direction for engaging students in both classroom settings. The class which adopted continuous informal discussion approach rendered more

enjoyment among students, although the traditional formal assessment activities showed higher student participation. Thought these findings are at a very initial stage, they give some indication on how real-time audience engagement tools can be developed within classroom settings for assisting in teaching and learning practices.

Keywords

Technology enhanced learning tools, audience interaction, student engagement, student participation.

2.1 INTRODUCTION

Today digital technologies are integrated with people's lives. These technologies have become a primary source of acquiring information for people. Therefore, it is conducive if these technologies can be combined in students' learning process in educational settings. One of the strategies to leverage the benefits with technologies in classes is the use of synchronous tools. In large classes, it is often hard to maintain participation of students. Students may prefer to stay silent in classes due to different reasons such as peer pressure, risk avoidance, anxiety, and cultural reasons. It is also mentioned that there is fear among students to interact with teaching staff in class due to evaluation anxiety, being judged by others, or being the focus of attention (Weaver & Qi, 2005). However, in large audiences knowing the level of audience understanding of the current topic can aid lecturers in many ways. Lecturers can then adapt their teaching style and their speed of teaching to increase the understanding of the audience. Thus, getting quality and timely feedback can help teachers overcome the problem of disengagement and boredom in large audiences (Cue, 1998; Zhu, 2007).

This study investigates students' perception in regards to using audience interaction technologies to bring about synchronous interactions in classrooms. This has been done by using a web-based tool (Xorro-Q) in two classroom settings. A theoretical framework utilising Activity Theory (AT) underpins the research study design. Two different teaching pedagogies, namely activity-based (to stimulate discussions in classrooms) and traditional (to assess student learning) have been employed. The objective of the study was to understand the students' views on how the tool helped them in the process of learning and becoming engaged in the two separate classroom environments. Findings have indicated that audience-interaction tools such as Xorro-Q can assist in both traditional and activity-based pedagogies and give a promising research direction for enhancing student engagement in different

classroom settings. The following sections give an overview on background literature and theoretical framework, study design, preliminary study findings and proposes future research directions.

2.2 LITERATURE REVIEW

To enhance the teaching and learning experience of students, it is important to increase student motivation and keep them engaged in class. Teachers use different techniques in class for their teaching. Many studies have been conducted about different styles of teaching in lectures (McKeachie, 1990; Saroyan & Snell, 1997). In traditional teaching, the teacher is central, as subject content is transferred one-way from teacher to the students. In this method of teaching, students receive the information from the teacher or from the textbook. Assessment is based on either right or wrong answers. The curriculum in this method encourages a lecturing type of teaching because there is a strong focus on facts which involve a large number of subject related vocabulary (Leonard & Chandler, 2003, p. 5). However, new teaching methodologies emphasize collaborative learning and stress that learning can be improved through ongoing dialogue between teachers and learners (Draper, Cargill, & Cutts, 2002). Students learn more by engaging in class and doing activities compared to sitting in class and passively listening to the lecturer. Collaborative learning accentuates the characteristics of the group rather than those of the individual (Chickering & Gamson, 1987; McConnell, 1996). The role of interactivity has a positive impact on the success of the course and consequently on the overall student learning process (Steinert & Snell, 1999).

Sibley and Spiridonoff (2010) suggest using team and group learning in order to accelerate active and collaborative learning. Team based learning (TBL) suggests changing the class format from lecture-based to team-based. Team members use their time to apply and evaluate course materials instead of just acquiring the materials. Further, in TBL each member of the group is responsible for a specific portion of the assignment, which is considered better compared to group learning, since some students may not pull their part in the group. Weaver and Qi (2005) also support the idea that students learn more when they are actively engaged in the class. They suggest that teachers should use different methods to increase class participation for supporting student-driven learning.

A large number of empirical studies affirm that students learn better when they tackle questions in class rather than passively listen to answers (Waldrop, 2015). Researchers from different disciplines emphasize the importance of using active learning in undergraduate classes to enhance student learning

(Kober, 2015; Singer & Smith, 2013). This can be done through workshops, classroom discussions, debates, and using examples which are not taken directly from the textbook. Studies suggest that students' retain more subject knowledge and their scores could improve by 20% when active learning is used, whereby students engage in discussions during classes (Dörner, 1996; Wieman, 2014).

These findings resonate with a long established learning theory that is called activity theory (AT), which was first defined by Leont'ev (1974). AT was later extended by Engeström (2001), and it has now become a useful theoretical framework for exploring social relationships across different disciplines involving human computer interaction scenarios such as in requirement gathering, software development, education, and healthcare (Georg & France, 2013; Hasan, 1999). Further, Murphy and Manzanares (2008) add that each element of activity theory can be impacted by emerging technologies. For example, the component of traditional classrooms can be replaced by virtual classrooms and tools such as chalk and board could be replaced by emails, software apps and message texting. There are many studies conducted about the use of different technologies in educational environments (Park & Farag, 2015; Ravishankar et al., 2014b). This study too will explore classroom settings using an audience interaction tool (Xorro-Q) to identify ways to enhance student participation and learning. Xorro-Q is a new web-based tool that can be used to increase the level of engagement between students and lecturers. Xorro-Q supports a variety of pedagogies needed for assessing students' understanding, providing feedback to the students based on their learning, enabling classroom discussion for students and lecturers, and enabling lecturers to instantly adapt their instructions based on student responses.

2.3 THEORIZING WITH ACTIVITY THEORY

Vygotsky (1980) (published first 1931) and his collaborators in Russia coined the socio-cultural approaches to learning and development (Feryok, 2012; Lantolf & Appel, 1994). They argued that human mental functionalities are mediated processes organized by socio-cultural artifacts. Several socio-cultural theories have been derived from Vygotsky's work (Lantolf, Thorne, & Poehner, 2000; Valsiner, 2007; Van Lier, 2002). Engeström (2001) state that all these approaches share one common theme that is human action is mediated. However, these approaches differ in how mediation is actually theorized. Leont'ev (1974) developed Vygotsky's meaningful social activity as a form of mediation which was known as activity theory. Leont'ev (1974) state that activity theory differentiates between individual goals and objectives at the action level, and social goals and objectives are

differentiated at the activity level. Concrete operations are then utilized to achieve goals and objectives.

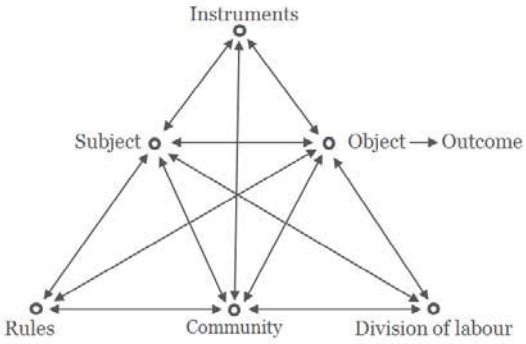

Figure 2.1: Activity theory (Engeström, 2001)

A model of activity theory is depicted in **Error! Reference source not found.**. In the model the top triangle represents the mediating elements (tools, rule, and division of labour) while the inner triangle represents the mediated elements (subject, community, and object). The main primary focus of any activity is the object (or aim). The use of the term 'object' causes much confusion and some authors prefer to use the term 'aim' instead (Georg et al., 2015). The overall aim of the mediating relations is an outcome (or transformation) as a result of execution of the activity. Any activity is performed using combination of the subject, the object and the tool (instrument). The operation and action would affect the outcome. The subject would be individuals or group of actors involved in the activity. The object would be the production of the activity. Instrument would be anything used in the transformation process. The community would be the interdependent aggregate who share a set of social meanings. Rules are guidelines which guide the actions in order to be acceptable by the community. The division of labour would be the task specialization by individual members of the group.

Activity theory has been used in different disciplines in education and organizational learning (Basharina, 2007; Foot, 2001; Murphy & Rodriguez-Manzanares, 2008). This study has been theorized with AT contextualized elements to investigate student engagement with an audience interaction tool in two different classroom settings. In activity theory the most appropriate unit of analysis is the activity. Since the focus of our Xorro-Q tool is engaging students in simple activities (e.g., answer in one word, select one option) in class, activity theory is particularly well suited to our study of classroom

learning. In this theory all purposeful human activities would be a result of interaction among six elements namely subject, object, tool, community, rules and division of labour.

2.4 ACTION RESEARCH METHODOLOGY

For the purpose of this study we have used action research. Creswell, Hanson, Plano, and Morales (2007) classify action research as practical and participatory. Perhaps the one definition which considers both practical and participatory action research belongs to Rapoport, who defines action research as follows:

> Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework (Rapoport, 1970, p. 499).

Action research is applied in nature which means it starts with a practical problem. Then it attempts to find a solution to the problem. Action research is best applied in educational and organization settings where educators, teachers and practitioners want to reflect on their own practices (Mills, 2000). Generally, action research is designed with some intervention approach in order to change the status quo and to address a concern or solve a specific problem. This research attempts to improve the participation of university students in their classrooms. To address this problem, we have introduced a tool (Xorro-Q) as an intervention which we believe could help increase students' participation in the courses. Quantitative data is collected using the tool. This includes data about student attendance, participation rate of students in the activities and assignments, and their scores in the activities. We also collected qualitative data through open-ended questions from students to get an understanding about their classroom experience. The quantitative and qualitative data have been analysed to help determine whether or not, and, how our tool could help improve students' participation.

2.5 RESEARCH DESIGN

The Xorro-Q tool was used in two undergraduate classroom settings in a New Zealand University (NZU) in the second half of a teaching semester. The courses have been selected randomly. This tool collects quantitative data regarding students' participation in the class. This included number of questions seen by the students and number of questions which were answered by them. In one classroom setting which was a first year computing course, the lecturer employed activity-based teaching techniques with the Xorro-Q tool; while the lecturer in the other classroom setting involving a second year computing course employed Xorro-Q for assessing students subject knowledge using traditional

methods. The student enrolment in the first year course was 120 and in the second year course it was 50; however, attendance was about 30% for the first year course and 50% for the second year course. Students were told that there were no marks for in-class participation. The number of questions used in the two classes varied. In the first year course, activity theory elements were applied through the class, where text-based questions were asked and students' responses were displayed to the whole class through word-clouds. In the second year course, traditional teaching pedagogy was employed. The lecturer asked multi-choice and concept type questions at the end of the class to assess the level of understanding among students on the conceptual subject content.

2.6 MAPPING THE RESEARCH DESIGN WITH ACTIVITY THEORY

The activity theory construct has been applied in social sciences and in computing sciences such as human-computer interaction and software development (Fuentes-FernÁNdez, GÓMez-Sanz, & PavÓN, 2007; Georg et al., 2015). The theoretical underpinnings of AT has helped researchers to understand possible mediations between theoretical constructs to achieve desired outcomes. In this study we utilize the social science aspect of activity theory to get recommendations from students on how best we should design a dashboard which appeals to them. In Figure 2, we have aligned the activity theory elements with our study.

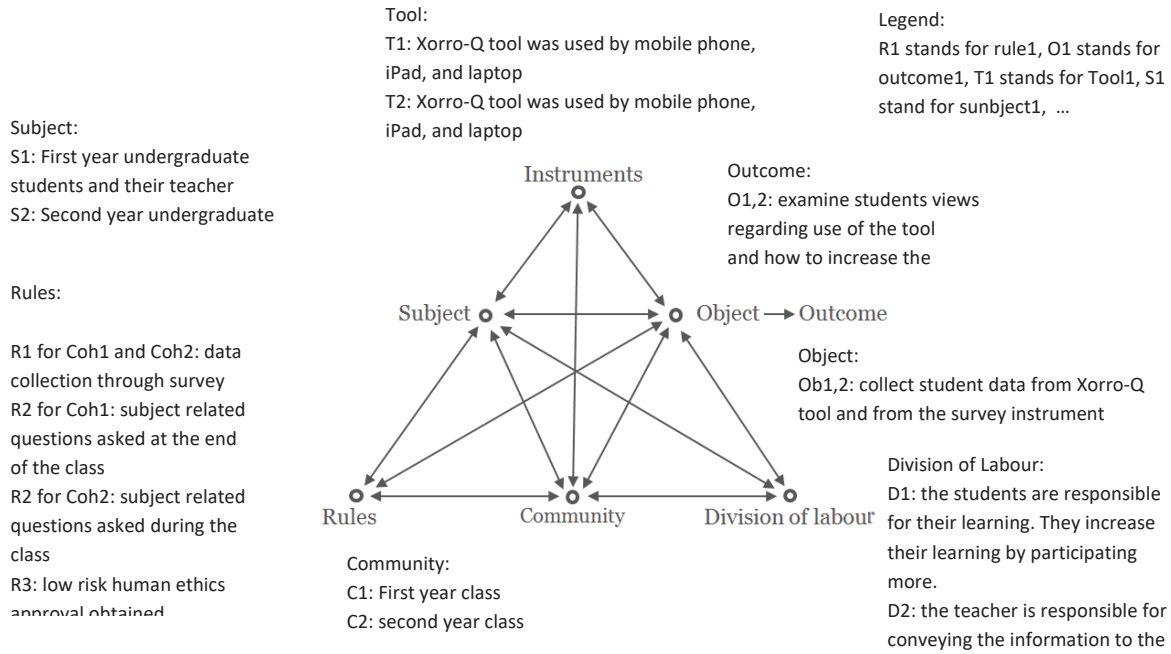

Figure 2: Mapping activity theory constructs with our study's design

The seven constructs (subject, instrument, rules, community, division of labour, object/aim and outcome) used in the context of this study are explained next. The *subject* is the teacher considering his/her teaching experience, teaching approach, and the students. The *instrument* is the underlying audience engagement tool Xorro-Q. The *rules* are the expectations of the teachers and the evaluation criteria. The *community* is the class environment which is mediated by rules. In a class, students can discuss their issues with their classmates before they submit their answers. *Division of labour* is related to the students, teachers and their responsibilities in class. The lecturer is responsible for teaching and asking questions through Xorro-Q. The students participate in class activities and are themselves responsible for their learning. For every human activity there is an aim or *object*. The object could be physical or conceptual. The *outcome* would be the result of executing an activity. Our objective is to understand how students considered the use of the tool could help them engage in class and in the process of learning.

2.7 DATA ANALYSIS

We next used Xorro-Q to analyse our data. Xorro-Q has a dashboard to inform teachers and the institution manager about the participation of students and activity of the lecturer in the class. By participation we mean the number of questions seen by the students and the number of answers given by individual students. To find the participation percentage, the two numbers are divided and the percentage is analysed. We categorized the students' participation into four different groups. (1) not attending the class, (2) initiating (participation less than 20%), (3) participating (participation between 20%-80%), (4) engaging (participation more than 80%). Question impression refers to the number of questions which students were exposed to. The tool lists each question as an activity. Therefore, the number of activities run by the lecturer implies the number of questions asked in the classroom.

In the final week of the semester, we used a Student Engagement Questionnaire (SEQ) to capture student perceptions on the use of the audience interaction tool (Xorro-Q) intervention. The online survey (SEQ) was floated to both classes. Overall 15 students from the first year class (i.e., 12.5%) and 18 students from the second year class (i.e., 36%) answered the survey questions. The data collected from the classroom sessions via Xorro Q and the survey questionnaire have been analysed next to gain further understanding on how audience interaction tools can be applied to different classroom environments.

2.7.1 Analysing Students' Participation Data

This section analyses activities of students and lecturers during the class. Figure 3 shows activities which have been run in two classes by two different lecturers. The diagram shows on the number of questions asked in each of these classes. The student participation percentage is calculated based on the number of responses received to the questions asked. Thus in the first year class, 98 questions were asked to a group size of 188 students to which 51% of students responded. In the second year class, 74 questions were asked to a group size of 60 to which 92% of students responded. The size of the circles also shows the size of the class.

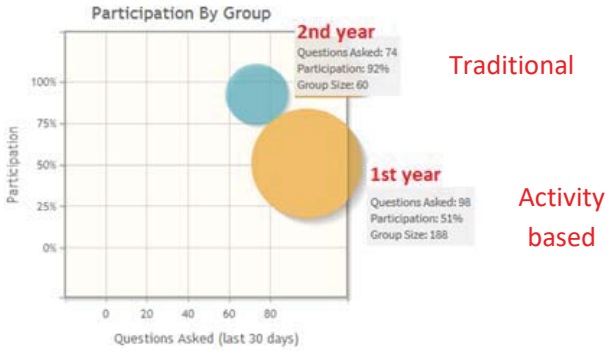

Figure 3: Group comparison

The engagement history of the lecturer in the first year and second year courses are shown in **Error! Reference source not found.** and **Error! Reference source not found.**. The engagement history refers to how the engagement metrics have been changing over a specified interval of time. The chart describes what proportion of an audience (averaged as determined through the filters) is attending, initiating, participating or engaged.

Figure 4: Engagement history for the first year course

The figures show how many percentages of students from those students who attended the class were in the initiating, participating, and engaging stage. This is reported by counting the number of participants logged in at the time the question was asked. However, if a participant joins an activity late, then question impressions will not count that participant for the questions asked prior to his joining.

Interestingly **Error! Reference source not found.** and **Error! Reference source not found.** show that the students in the class were engaged more in the second year class (where assessment questions were asked) than the first year class (where discussion questions were asked).

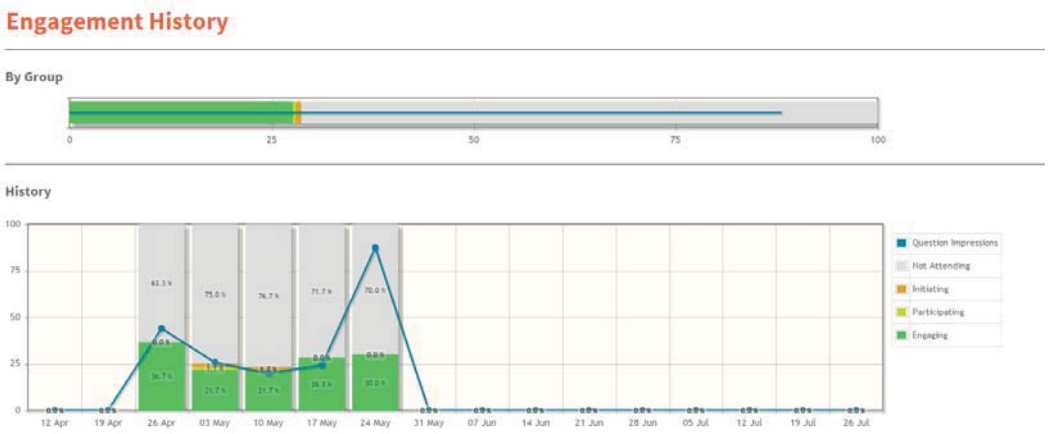

Figure 5: Engagement history for second year course

2.7.2 Survey Data Analysis

Statistical analysis in the form of percentage has been used to analyse student participation and satisfaction in regards to the use of Xorro-Q in their classes. Four Likert scale survey questions were used to gauge student satisfaction on the impact of using audience participation tool (Xorro-Q) in their learning process and interest in the course. Students were asked whether raising questions during the classroom sessions through audience interaction tools could help them in their learning process and increase their interest in the course. Students were also asked if asking questions through the tool made them more attentive and engaged in class. **Error! Reference source not found.** shows the data from the first year and second year course for these three questions. We realise that the number of responses relative to the class strength is rather low (12.5% for the first year course and 36% for the second year course); however, it gives some indication on how students' view their learning process.

	Helped me to learn		Helped me to increase interest		Made me more attentive and engaged	
	C1: 1st yr course	C2: 2nd yr course	C1: 1st yr course	C2: 2nd yr course	C1: 1st yr course	C2: 2nd yr course
A lot	40%	27.77%	30%	22.22%	70%	27.77%
Somewhat	60%	61.11%	60%	55.55%	20%	44.44%
A little	0	11.11%	10%	16.66%	10%	11.11%
Not at all	0	0	0	5.55%	0	16.66%

Table 1: Statistics for students' idea regarding usefulness of the tool

When the students were asked whether Xorro-Q helped them to learn when they compared their results with other students' results displayed on the board in the classroom, students in class where Xorro-Q tool was continuously used mentioned that the tool helped them when they compared their results with other students' results.

	C1: 1st yr course	C2: 2nd yr course
I enjoyed it	80%	44.44%
It was OK	20%	38.89%
I have no opinion as such	0%	5.55%
It was a waste of time	0%	11.11%

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	C1: 1st yr course	C2: 2nd yr course

I enjoyed it	80%	44.44%
It was OK	20%	38.89%
I have no opinion as such	0%	5.55%
It was a waste of time	0%	11.11%

Table 2: Statistics for students' enjoyment

Error! Reference source not found. summarizes general impressions in regards to the asking of questions during the class using Xorro-Q. These findings show that first year students who used the tool continuously in the class enjoy using the tool more compared to the second year students.

	C1: 1st yr course	C2: 2nd yr course
A lot	50%	22.22%
Somewhat	30%	33.33%
A little	20%	22.22%
Not at all	0%	22.22%

Table 3: Statistics for students' general impression

It was interesting that in our survey none of the students liked to see the results displayed alongside their names in the class. Students prefer to remain anonymous in public places like classrooms where they can be judged. Although classroom interaction helped them learn as indicated in **Error! Reference source not found.**, the students were not keen to have their names displayed on the board. These two statements contradict each other. We can only speculate that whenever students are being assessed, they prefer to keep their identity confidential. The next phase of the study will investigate these findings further.

There were also some open-ended questions in our survey instrument. Students' answers to open-ended questions show that students generally have a positive feedback towards using audience interaction tools in classes. Students were asked about their most and least favourite feature in Xorro-Q. According to the students' responses, ease of use, user friendliness, getting immediate feedback during progression

in class, and overall classroom interactivity had helped them retain information that they just learnt in the lecture which was the strength of the tool. However, other students indicated that some people were posting irrelevant things to the board which was inappropriate and distracting. Students also did not want their names to be displayed on the board and preferred to remain anonymous.

2.8 DISCUSSION

Questions are raised on data gathered from Xorro-Q regarding engagement history and from SEQ regarding engagement in the class. **Error! Reference source not found.** indicates that students are more satisfied when such tools are used continuously to engage them through discussions compared to the time when it was used once to assess their acquired knowledge at the end of the class.

Findings in **Error! Reference source not found.** show that in the first year course with activity pedagogy where the tool was used continuously for discussions, 80% of the students who attended classes reported that they enjoyed the ongoing exchanges in the classroom, while 20% of the same students found it satisfactory. In the second year course with traditional pedagogy where the tool was used near the end of the class to assess student learning, 44.5% of the students attending classes reported that they enjoyed answering questions, 39% found it satisfactory, while remaining students either did not like it or were noncommittal. We found that whilst engagement history of the second year class in which traditional teaching methods was employed shows higher level to engagement, the student responses indicate lower level of enjoyment. Similarly in the first year class where activity based teaching methods were employed, while students were less engaged in answering questions through the tool, students enjoyed it more.

Students were asked what their general impression was regarding the asking of questions during the class using Xorro-Q. Our findings show that students enjoyed usage of such tools more for informal discussions rather than for assessment purposes (**Error! Reference source not found.**). This finding re-affirms the earlier finding that although engaging in assessment was higher, the students do not enjoy being assessed. Students enjoyed more through informal classroom discussions, although some of the students though present did not participate.

2.9 CONCLUSION AND FUTURE WORK

In this study the use of audience interaction tool has been investigated in two undergraduate courses at NZU. Our aim was to examine how using this tool could help students in the process of their learning,

and keep them engaged and interested during class. This study drawing on activity theory (Leont'ev, 1974) looked at the engagement of students in two undergraduate courses. One of the courses applied a traditional methodology and the other one was activity oriented. Applying the elements of the activity theory as discussed by Engeström (2001) to our classroom settings, we found that audience participation tool has a promising direction for engaging students in the process of teaching and learning. However, engagement in the form of assessment is found to be higher, while engagement in the form of informal discussions may have less student participation, but, is considered more enjoyable. The data collected through our tool showed that the class which adopted an activity-oriented approach rendered better results as far as enjoyment of students is concerned while traditional classes showed higher engagement. The tool has proved to be effective in providing new insights to lecturers, students, and the institution, and has potential to help all the parties involved so that the right decisions are made regarding the efficacy of the teaching and learning, and the evaluation process. However, there are a few limitations in this study. For example, the study has been conducted in the second half of the teaching semester. It would have been better if we could have run the test from the beginning of the course to the end and put students under focus from the start to understand how their level of engagement has changed during the course. Also, the low attendance and low response to the final survey tool are other limitations of this study.

However, the study has shed some light into how audience engagement tools can be used in classrooms when different pedagogies are used. We plan to extend this study with different combinations of pedagogies in different subject areas to understand how such systems affect and engage students in the process of learning. In the process, we hope to tailor certain features of the current on-line audience interaction tools to provide a friendlier space for student-driven learning and for knowledge acquisition and assessment. Future work will extend the experimental design to classes where the teacher and students remain the same, but the teaching pedagogy will vary across traditional, activity-based and team-based settings. This design will be repeated across different undergraduate classes. Further, qualitative data through interviews with teachers and students will be collected to contextualize socio-cultural aspects of teaching and learning practice. It is hoped that this study will offer rich insights on the role of audience interaction tool and have innovative pedagogical implications in teaching and learning.

2.10 REFERENCES

Basharina, O.K. 2007. "An Activity Theory Perspective on Student-Reported Contradictions in International Telecollaboration," *Language Learning & Technology* (11:2), pp 82-103.

Chickering, A.W., and Gamson, Z.F. 1987. "Seven Principles for Good Practice in Undergraduate Education," *AAHE bulletin* (3), p 7.

Creswell, J.W., Hanson, W.E., Plano, V.L.C., and Morales, A. 2007. "Qualitative Research Designs Selection and Implementation," *The counseling psychologist* (35:2), pp 236-264.

Cue, N. 1998. "A Universal Learning Tool for Classrooms," *Proceedings of the First Quality in Teaching and Learning Conference*, pp. 10-12.

Dörner, D. 1996. "The Logic of Failure: Why Things Go Wrong and What We Can Do to Make Them Right,").

Draper, S.W., Cargill, J., and Cutts, Q. 2002. "Electronically Enhanced Classroom Interaction," *Australasian Journal of Educational Technology* (18:1).

Engeström, Y. 2001. "Expansive Learning at Work: Toward an Activity Theoretical Reconceptualization," *Journal of education and work* (14:1), pp 133-156.

Feryok, A. 2012. "Activity Theory and Language Teacher Agency," *The Modern Language Journal* (96:1), pp 95-107.

Foot, K.A. 2001. "Cultural-Historical Activity Theory as Practice Theory: Illuminating the Development of Conflict-Monitoring Network," *Communication Theory* (11:1), pp 56-83.

Fuentes-Fernandez, R., Gomez-Sanz, J.J., and Pavon, J. 2007. "Managing Contradictions in Multi-Agent Systems," *IEICE transactions on information and systems* (90:8), pp 1243-1250.

Georg, G., and France, R. 2013. "An Activity Theory Language: Use Implementation," *Colorado State University Computer Science Department Techn. Report, CS-13-101, http://www.cs.colostate. edu/TechReports/Reports/2013/tr13-101. pdf (acc*).

Georg, G., Mussbacher, G., Amyot, D., Petriu, D., Troup, L., Lozano-Fuentes, S., and France, R. 2015. "Synergy between Activity Theory and Goal/Scenario Modeling for Requirements Elicitation, Analysis, and Evolution," *Information and Software Technology* (59), pp 109-135.

Hasan, H. 1999. "Integrating Is and Hci Using Activity Theory as a Philosophical and Theoretical Basis," *Australasian Journal of Information Systems* (6:2).

Kober, N. 2015. *Reaching Students:: What Research Says About Effective Instruction in Undergraduate Science and Engineering*. National Academies Press.

Lantolf, J.P., and Appel, G. 1994. *Vygotskian Approaches to Second Language Research*. Greenwood Publishing Group.

Lantolf, J.P., Thorne, S.L., and Poehner, M.E. 2000. "Sociocultural Theory and Second Language Development,").

Leonard, W.H., and Chandler, P.M. 2003. "Where Is the Inquiry in Biology Textbooks?," *The American Biology Teacher* (65:7), pp 485-487.

Leont'ev, A.N. 1974. "The Problem of Activity in Psychology," *Soviet psychology* (13:2), pp 4-33.

McConnell, J.J. 1996. "Active Learning and Its Use in Computer Science," *ACM SIGCSE Bulletin* (28:SI), pp 52-54.

McKeachie, W.J. 1990. "Research on College Teaching: The Historical Background," *Journal of Educational Psychology* (82:2), p 189.

Mills, G.E. 2000. *Action Research: A Guide for the Teacher Researcher*. ERIC.

Murphy, E., and Manzanares, M.A.R. 2008. "Contradictions between the Virtual and Physical High School Classroom: A Third-Generation Activity Theory Perspective," *British Journal of Educational Technology* (39:6), pp 1061-1072.

Murphy, E., and Rodriguez-Manzanares, M.A. 2008. "Using Activity Theory and Its Principle of Contradictions to Guide Research in Educational Technology," *Australasian Journal of Educational Technology* (24:4).

Park, and Farag. 2015. "Transforming the Legal Studies Classroom: Clickers and Engagement," *Journal of Legal Studies Education* (32).

Rapoport, R.N. 1970. "Three Dilemmas in Action Research with Special Reference to the Tavistock Experience," *Human relations* (23:6), pp 499-513.

Ravishankar, J., Epps, J., Ladouceur, F., Eaton, R., and Ambikairajah, E. 2014. "Using Ipads/Tablets as a Teaching Tool: Strategies for an Electrical Engineering Classroom," *International Conference on Teaching, Assessment and Learning (TALE)*: IEEE, pp. 246-251.

Saroyan, A., and Snell, L.S. 1997. "Variations in Lecturing Styles," *Higher Education* (33:1), pp 85-104.

Sibley, J., and Spiridonoff, S. 2010. "What Is Tbl?," *Retrieved February* (23), p 2011.

Singer, S., and Smith, K.A. 2013. "Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering," *Journal of Engineering Education* (102:4), pp 468-471.

Steinert, Y., and Snell, L.S. 1999. "Interactive Lecturing: Strategies for Increasing Participation in Large Group Presentations," *Medical Teacher* (21:1), pp 37-42.

Valsiner, J. 2007. "Culture in Minds and Societies: Foundations of Cultural Psychology," *Psychol. Stud.(September 2009)* (54), pp 238-239.

Van Lier, L. 2002. "An Ecological-Semiotic Perspective on Language and Linguistics," *Language acquisition and language socialization: Ecological perspectives*), pp 140-164.

Vygotsky, L.S. 1980. *Mind in Society: The Development of Higher Psychological Processes*. Harvard university press.

Waldrop, M.M. 2015. "The Science of Teaching Science." London, England: Nature Publishing Group Macmillan

Weaver, R.R., and Qi, J. 2005. "Classroom Organization and Participation: College Students' Perceptions," *The Journal of Higher Education* (76:5), pp 570-601.

Wieman, C.E. 2014. "Large-Scale Comparison of Science Teaching Methods Sends Clear Message," *Proceedings of the National Academy of Sciences* (111:23), pp 8319-8320.

Zhu, E. 2007. "Teaching with Clickers," *Center for research on learning and teaching occasional papers* (22), pp 1-8.

Chapter 3

Is Participatory Pedagogy Useful and Satisfying for Tertiary Students?

Shadi Esnaashai

School of Engineering and Advanced Technology

Massey University

Auckland, New Zealand

Email: S.Esnaasahri@massey.ac.nz

ABSTRACT

There has been a seismic shift in recent years away from monolithic lectures to more active and participatory learning in recent years. While wikis and online, asynchronous learning has received significant attention, increasing in-class participation to improve outcomes has also been a focus for many teachers in post-school environments. In this study, we endeavoured to understand whether a more participatory learning approach might be perceived as more useful and satisfying for tertiary students in New Zealand. The results indicate that students are willing and motivated to engage in new approaches to learning and teaching in the classroom.

Keywords

Technology enhanced learning tools, audience interaction, student engagement, student participation.

3.1 INTRODUCTION

In educational settings, it is important to increase students' motivation and keep them engaged in class in order to enhance their teaching and learning experience. Teachers use different techniques in class for their teaching (McKeachie, 1990; Saroyan & Snell, 1997). Community and activity based teaching methodologies emphasize collaborative learning and stress that learning can be improved through on-going dialogue between teachers and learners (Draper et al., 2002). Students learn more by engaging in class and doing activities rather than not contributing to and engaging in the activities. The importance of participation of students in class has been emphasized (Chickering & Gamson, 1987; Dearn, 1996; Kober, 2015; McConnell, 1996; Sibley & Spiridonoff, 2010; Singer & Smith, 2013); and it has been stated that students need to participate in group activities in class to learn more. A large number of empirical studies affirm that students learn better when they tackle questions in class rather than passively listen to answers (Waldrop, 2015). Studies also suggest that students retain more subject knowledge and their scores could improve by 20% when they engage in discussions during classes (Dörner, 1996; Wieman, 2014).

One of the strategies to leverage the benefits with technologies in classes to increase the interaction between students with each other and the teacher is the use of synchronous tools. In large classes, it is often hard to maintain participation of students. Students may prefer to stay silent in classes due to different reasons such as peer pressure, risk avoidance, anxiety, and cultural reasons. It is also mentioned that there is fear among students to interact with teaching staff in class due to evaluation anxiety, being judged by others, or being the focus of attention (Weaver & Qi, 2005). However, in large audiences knowing the level of audience understanding of the current topic can aid lecturers in many ways. Lecturers can then adapt their teaching style and their speed of teaching to increase the understanding of the audience. Thus, getting quality and timely feedback can help teachers overcome the problem of disengagement and boredom in large audiences (Cue, 1998; Zhu, 2007).

To date, different techniques and technical tools have been used to enhance learning (Park & Farag, 2015; Ravishankar et al., 2014a, 2014b). For example, studies about the use of technology in class or in short, Response Systems (RSs) date back to 1966 at Stanford University and consequently at Cornell University (Littauer, 1972). RSs enable the instructor to gauge understanding of students in a real time for a given topic. The personal response systems were invented during the 1980s. During the 1990s the education institutes started using these tools. Over time with current improvements in technology, the

RS systems have become simpler and more user friendly. One of the many response systems that are still widely used especially in large audiences are clickers. Since 1980, clickers have been used to assess knowledge and identify misconceptions before giving students an insight to new subjects. Different studies conducted around the world show satisfaction among students and a positive attitude towards the use of response systems (Beekes, 2006; Preszler, Dawe, Shuster, & Shuster, 2007). However, there are certain challenges in the use of clickers from students' and lectures' points of view, such as the cost of purchasing, the cost of having one person distribute the clickers, then collect them back and check the battery life. Web based applications which came to address the issues of using clickers seem to be the preferred choices now. There are different web based tools available in the literature [http://www.socrative.com/, https://plickers.com/,https://getkahoot.com/, https://tophat.com/]. All these kinds of tools collect the data from students' activities in their classes. This enables the researchers to use the data to mine them so that they find out about the learning process of the students. This study investigates students' perception in regards to using audience interaction technologies to bring about synchronous interactions in classrooms. The discussion in this study is based on activity theory (AT) and self-regulated learning. AT has now become a useful theoretical framework for exploring social relationships across different disciplines involving human computer interaction scenarios such as in requirement gathering, software development, education, and healthcare (Georg & France, 2013; Hasan, 1999). While it is well documented that each element of the activity theory is very important in the success of the activity, the ability of the student to self-regulate learning is critical in the development of learning (Zimmerman, 2002).

3.2 LITERATURE REVIEW

In this section an overview of the learning analytics, current technologies which have emerged to help the students and the lecturers to understand the process of learning are explained. In addition, educational theories, and the gap in the field are discussed. Finally the learning theories which could help to understand the process of engaging the students with the tool to self-regulate their learning has been given.

Learning analytics (LA) is defined according to the 1st International Conference on Learning Analytics and Knowledge (*Proceedings of the 1st International Conference on Learning Analytics and Knowledge*, 2011) as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs".

In learning analytics, the data will be interpreted in terms of learning. It is important how we interpret the learning process. The output of learning analytics spans the activities in higher education which could affect the university administrators' decision, teachers' decisions on learning and teaching, and students' success (Ryan SJD Baker & Yacef, 2009; Black, Dawson, & Priem, 2008; Hattie & Timperley, 2007).

There are different dashboard applications developed to address these needs and support learning and teaching support. These dashboards represent the graphical view of the current and historical data from the students, the teacher, and the content. This information can be used by the teacher, the students, and the university (Verbert, Duval, Klerkx, Govaerts, & Santos, 2013; Verbert et al., 2014). In the following section an overview of different dashboards which were developed to address these needs and support learning and teaching is given.

Learning analytics dashboards are applications which can show the behavior of students in learning environments. This application uses students' data regarding their participation in the log files, class activities, assignments, and mine the data to find a meaningful pattern out of that and visualize it in a way that the information is comprehensive at a glance.

For example, a graphical interactive student monitoring and tracking system tool (GISM) was developed which extracted tracking data from a course management system for an online course. This tool is capable of providing the teachers with information about their course and students in the class to provide a better support for the learner (Mazza & Milani, 2004).

LOCO_Analyst is a dashboard for teachers. This tool provides the feedback for teachers regarding activities and students' performance in the activities. It shows the pattern of student learning and shows the result of self-assessments. This is one of the rare tools which have been evaluated (Ali, Hatala, Gašević, & Jovanović, 2012).

It is also important to give information to students about their learning process to help them in their learning process and increase their motivation. For example, Santos, Govaerts, Verbert, and Duval (2012) develop a dashboard which reflects students' activity in the courses and enables them to compare their results and achievements with other peers.

StepUp (Santos, Verbert, Govaerts, & Duval, 2013) is another dashboard which was designed to support awareness, self-reflection, sense making, and impact on learners. This tool targets both learners and their teachers in providing visualized data which reflects on the process of teaching and learning.

Course Signal is a dashboard for students. It can predict the students' outcome and visualize the data regarding students' grades, the amount of time students have spent on each task and their past performance. The student will receive traffic signal which could be red, green, or yellow based on how far it is from the threshold. Faculty members can also send personalized email to students based on the performance of the students in that specific course and can refer the students to different resources (Arnold & Pistilli, 2012).

Carnegie Mellon University (Dollár & Steif, 2012) has another dashboard for students called OLI. In their design they show whether the student meets their goal for the course or not. It shows the information regarding different courses for the students. The students can compare their achievement in different courses.

Student Activity Meter (SAM) is another dashboard which provides visualization for the students and their teachers (Govaerts, Verbert, Duval, & Pardo, 2012). It shows the pattern on engagement of student, and resource usage in Moodle over time.

In the University of Maryland, Baltimore County the researchers invented a tool called Check My Activity (Fritz, 2010); in this tool the learner compares its own activity with other anonymous students. This can help the students to know themselves better by providing them with information. The teacher also could use this information and give feedback and suggestions.

There has been much work on visualization on the results from learning analytics but there needs more to be done. This visualization works as feedback for teachers, students and universities. Therefore, it needs to be well studied so that it can give instructional feedback to them. For example, Corrin and de Barba (2014) studied the dashboard design to find out how different students interpret the visualized data differently. They discussed how good students' performance would lower when the good students compared their performance with their peers and realized that they had outperformed their peers. Therefore, it is recommended to consider the instructional design and learning theories when designing new dashboards.

Much of the work in learning analytics has focused on prediction but we need to remind ourselves that learning analytics should focus on learning. We need to bring learning theories to learning analytics to interpret the learning process of students in class considering the interactions between the students and

the teacher and the context of the course in different classes in different disciplines across different universities.

In what follows, we give a nation of activity theory, which is the overarching theoretical framework of this study, as a guiding framework to understand what it means to participate in class activities. Then we draw on self-regulated learning that is the desired goal of engagement in activities occurring as students take responsibility of their own learning and learn to regulate their own learning independently.

Vygotsky (1980) (published first 1931) and his collaborators in Russia coined the socio-cultural approaches to learning and development (Feryok, 2012; Lantolf & Appel, 1994). They argued that human mental functionalities are mediated processes organized by socio-cultural artifacts. Several socio-cultural theories have been derived from Vygotsky's work (Lantolf et al., 2000; Valsiner, 2007; Van Lier, 2002). Engeström (2001) state that all these approaches share one common theme that is human action is mediated. However, these approaches differ in how mediation is actually theorized. The theoretical underpinnings of AT has helped researchers to understand possible mediations between theoretical constructs to achieve desired outcomes. The seven constructs (subject, instrument, rules, community, division of labour, object/aim and outcome) used in the context of this study are explained next. The subject is the teacher considering his/her teaching experience, teaching approach, and the students. The instrument is the underlying audience engagement tool. The rules are the expectations of the teachers and the evaluation criteria. The community is the class environment which is mediated by rules. Division of labour is related to the students, teachers and their responsibilities in class. The lecturer is responsible for teaching and asking questions through the tool. The students participate in class activities and are themselves responsible for their learning. Our objective is to increase students' participation in the class and see how increasing the interaction affects students' course outcome. It is also important for us to understand how students considered the use of the tool could help them engage in class and in the process of learning. The outcome would be the result of executing an activity.

Within an activity theory perspective, learning is a process where an individual works on an activity in conjunction with other agents and engages in that activity, and is scaffolded by others who know that activity better through various sociocultural means. So long as the individual learns that activity and the socio-cultural rules behind participating in and performing that activity-which are culturally defined- the individual will learn to do it better and with ease, which means the activity has regulated the individuals'

learning behaviour. Now the activity theory can be connected with self-regulated learning which we believe will push the activity theory even further and add another layer to our discussions in learning about the theory. Self-regulated learning reflects on one's own learning, strategic action that is planning, monitoring, and evaluating one's own progress against specific criteria, and motivation to learn.

Self-regulation has been studied by behaviorists, cognitivists, and social constructionists. Behaviorists provided an account of self-regulation as a way to repair the disfunctionalities of the learners' behavior (e.g., (Meece, 2001)). Because behaviorists did not regard thoughts, emotions, and beliefs of the students and the role of mental faculties in this regard, they were strongly criticized by cognitivists. Cognitivists paid attention to the role of mind and considered learning as a mental process(Zimmermann, 2001). Although cognitive theories of self-regulated learning were a breakthrough in the 60s and 70s, they had their own flaws. One major flaw with the cognitivists' theories of self-regulation was a sole emphasis on the role of mind and mental powers as entities separable from the social environments. The 80s and 90s witnessed yet another turn within the learning field which was called the sociocultural turn following Leo Vygotsky's social development theory of learning. This study grounds itself within a sociocultural/sociocognitive framework of learning analytics where mind, body, and environment are inseparable parts in the learning process. Sociocognitivists (Bandura, 1986) extend the domain of cognition by extending it to the social context of learning. This notion of cognition is an extension of the early views of cognition in which cognition was regarded as "mind in a vat". This study although appreciates the role of cognition in individuals' development, it connects cognition to the wider social world where social activities and practices are embedded.

This process is reflected in Winne (2006) . Winne defines self-regulated learning based on three axioms: learners construct their knowledge, learners are agents, and data include randomness. To explain how learners construct knowledge, five facets are identified. Learners use tools, to operate on raw materials, to construct a product, which is evaluated in a formative way or summatively with respect to standards of social cultural kinds. Learners are agents which means that they decide what to study and when to stop their studies. Students evaluate themselves during the process of learning. There is randomness in data but a central tendency prevails. Scores are the most related variable to learning, achievement tests, attitude, and motivation in research in educational psychology. Under this assumption there is a particular interpretation for mean and score variance. Since there are random factors, the score differs from the mean. There are many different definitions for self-regulated learning, in this study, we follow

Winne (2006). Most theories of self-regulated learning consider motivation as having an interdependent relation with learning (Credé & Phillips, 2011; Gardner, 1995; Zimmerman & Martinez-Pons, 1988)

In order for the students to enhance their academic achievement, they need to be motivated so that they use strategies and regulate their efforts as well as their cognition (Paris & Oka, 1986; Pintrich, 1988). The activities, classroom environment, and students' cognitive efforts are fundamental in students' engagement and classroom performance (Ames & Archer, 1988). Zimmerman (2008) mentioned that in order for to the learners to take part in the activities to carry out cognitive and meta-cognitive strategies, learners should be motivated. When learners get engaged in the activities, they are either instrumentally or internally motivated. Instrumental motivation refers to a desire to reach a goal for a utilitarian purpose e.g. employment. Internal motivation refers to the desire of the individual to reach a goal without receiving utilitarian means.

In this study we build our discussion based on motivation theory by Pintrich (2000) which has an achievement goal theory about motivation and self-regulated learning. Based on the model suggested by Pintrich and De Groot (1990) there are three components of motivation that can be linked to three components of self-regulated learning.1) an expectancy component. This component is about the students' belief about their ability whether they can do the task or not. 2) a value component. This component is about how students think about the importance and interest of the task. This component is conceptualized in different ways such as learning v.s. performance goals, intrinsic v.s. extrinsic orientation, task value and intrinsic interest. All these different ways affect students' motivation for doing a task. 3) an effective component which determines students' feelings toward the task. This component is about student's feeling about the task.

3.3 METHODS

We are following a design based research method. In design based research at least two interventions will be applied- instructional and technological (Brown, 1992). Wang and Hannafin (Wang & Hannafin, 2005) defined design based research as a systematic but flexible methodology for improving the educational system. This practice will be done through interactive analysis, design, development, and implementation based on the collaboration between the researcher and participants in a real world setting. The results will be led to contextually sensitive design principles and theories. Based on Wand

and Hannafin (Wang & Hannafin, 2005) there are five characteristics in design based research "pragmatic, grounded, interactive, iterative and flexible, integrative, and contextual."

First, it is pragmatic due to having a goal for solving current real world problems. This would happen through designing and having interventions and extending the theories and refining design principles. Second, it is grounded because it is grounded in both theory and the real-world context. Third, it is interactive because design-based research is interactive, iterative and flexible. Fourth, it is integrative because in the design-based research the researcher needs different research methods and approaches from both qualitative and quantitative research paradigms depending on the needs of the research. Fifth, it is contextualized because its results are "connected with both the design process through which results are generated and the setting where the research is conducted" (Wang & Hannafin, 2005).

In what follows we address each of the characteristics of the design based research in our study.

1) Pragmatic, in this study we want to address the problem of students' low participation in the class. We want to see whether or not increasing the participation of students affects their course outcome. We suggest using our tool in order to increase the interaction between students and their teacher in the class to find out how increasing the interaction and engagement of students have an effect on course outcome.

2) Grounded, design based research has theory driven nature and it is more like a research paradigm than an evaluation method. It needs to identify a theory of learning and instruction. It is also grounded because the research will be run in a real world context and not in a laboratory. We run our study in a real classroom concentrating on the learning of students. Our study is sociocognotively oriented drawing on activity theory and self-regulated learning. From a design based research perspective theory development is linked to practice. The research needs to refine both theory and practice (Collins, Joseph, & Bielaczyc, 2004).

3) Interactive, iterative, and flexible, this study is a collaboration between participants and researcher in the process. Among designers, researchers, and participants, the distinction is indistinct. In this study we would like to understand which instruction work better and have a better effect on the course outcome of the students with audience partition tools.

4) Integrative, in our design research based study we used different approaches such as survey, questionnaire, expert reviews. The combination of these data sources and different methods enable us to have a high degree of objectivity and validity for our data.

5) Contextual, our design is connected to both design process and setting. The process through which the results were generated and the context where the research was conducted are important. Therefore, the research process, research findings, and the plan for each iteration should be documented.

3.3.1 Data Collection Tool (Xorro-Q)

Xorro-Q was used to collect students' data in the class. Xorro-Q is a real-time audience participation tool which can be used for in-class assessments as well as for non-assessed engagements such as brainstorming, and concept questioning. In this study Xorro-Q was used by the teacher to run activities in the class. The students participate in the activities through their internet enabled devices. The results of students' answers to the questions were collected by the Xorro-Q's server.

3.4. RESULT

We had run our tool in two different undergraduate classes. We collected data from around 500 students. The details of each of these case studies have been explained bellow.

3.4.1 Case Study 1

Xorro-Q was used in a 200 level Marketing course in the School of Business in a New Zealand university. The tool was used for 12 weeks in the course to collect participation data from students. The teacher asked questions of students through Xorro-Q on materials the teacher taught in the class in order to understand whether students understood the course. The questions were both open ended and multiple choices which allowed the teacher to understand if the students were able to get the core concepts.

The participation of students in lectures was monitored and reflected in their overall grade. The final grade for students consisted of the combination of two assessments based on the concepts of test and market analysis report, a presentation, and a comprehensive exam.

In the first session of the course, the teacher asked students to name the country where they were born and if the country of their birth was New Zealand, what the name the city was. As depicted in Figure 1, there is a mix of students from diverse backgrounds.

Figure 6: Diversity of students in case study 1

Diagram 1 shows the participation of students during the class. It shows activities which have been run in the classes by the lecturer. The diagram also shows the number of questions asked in the class. The percentage of student participation for this diagram is calculated based on the number of responses received for the questions asked. For example it shows for the last activity in the first year class, 17 questions were asked to a group size of 144 students to which 98% of students responded.

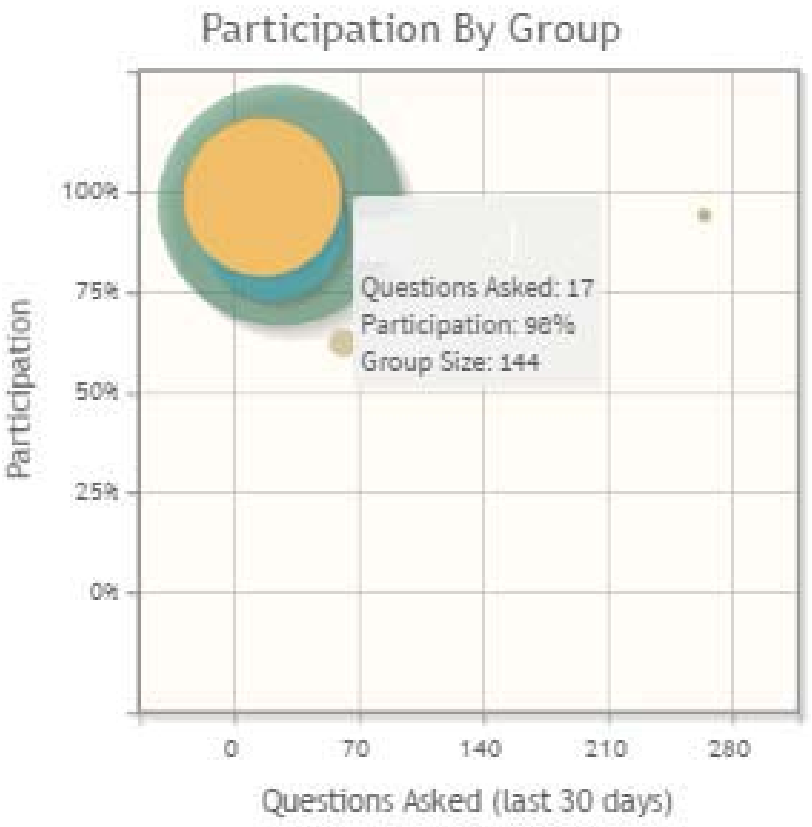

Diagram 1: Students participation in case study 1

3.4.2 Case Study 2

The Xorro-Q tool was used in a principal marketing course in the School of Business in a New Zealand university. The paper is designed to develop a basic understanding of consumers, market analysis, marketing planning, and marketing management. In the first session of the class the teacher asked students to write where they came from. As depicted in Figure 2 we had students from diverse backgrounds.

Figure 2: Diversity of students in case study2

Diagram 2 shows the participation of students for the last activity in the class. The activity was run for 345 students and the participation rate was 96%.

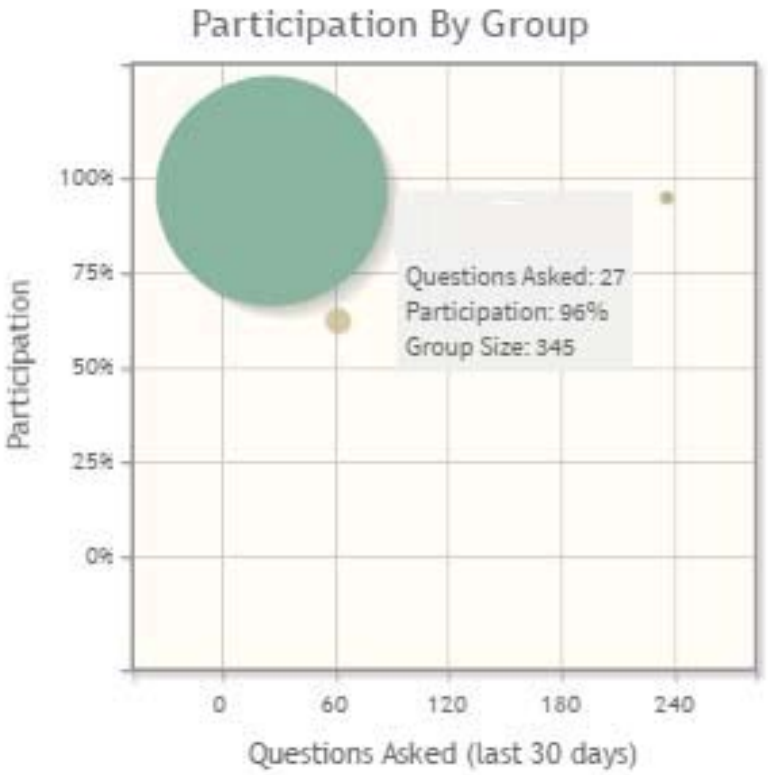

Diagram 2: Students participation in case study 2

3.4.3 Engagement History

The engagement history of the lecturer in the first year course in case study 1 is shown in Figure 3. The engagement history refers to how the engagement metrics has been changing over a specified interval of time. The chart describes what proportion of an audience (averaged as determined through the filters) is attending, initiating, participating or engaged. The figures show what percentage of students from those students who attended the class were in the initiating, participating, and engaging stage. This is reported by counting the number of participants logged in at the time the question was asked. If a participant joined an activity late, question impressions would not count that participant for the questions asked prior to his joining.

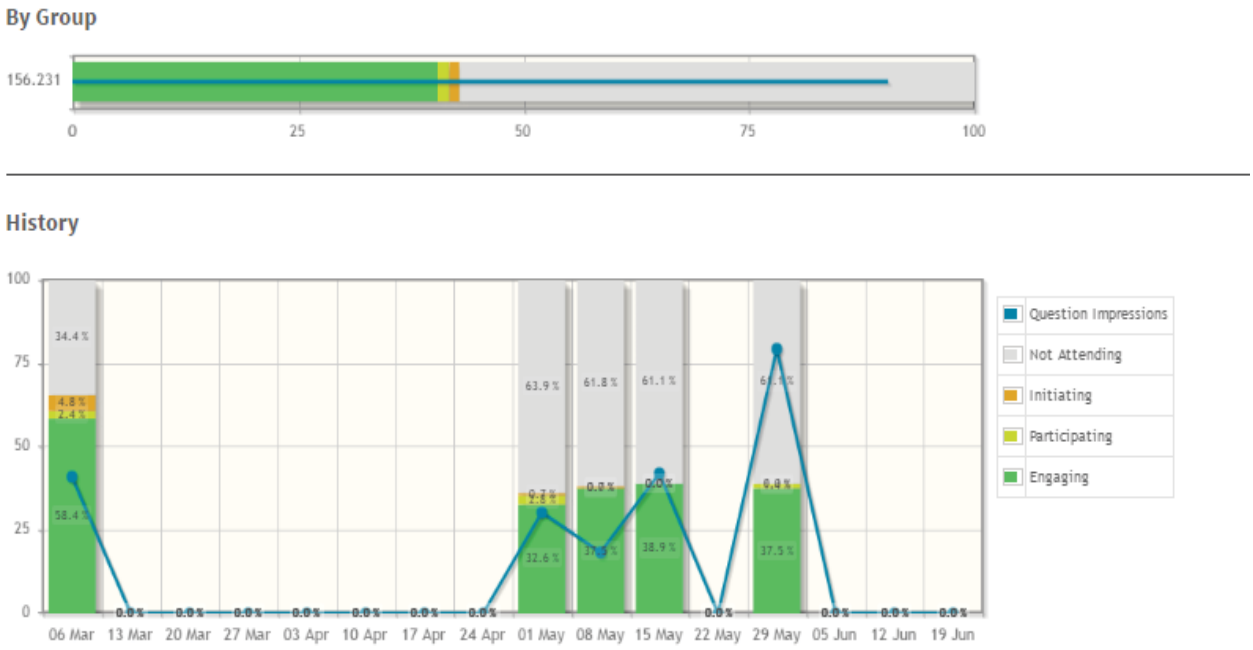

Figure 3: Engagement history case study 1

Figure 4 shows participation rate for the students and teacher activity for the duration of the course in case study 2. As the class was close to the end of semester, the participation of students reduced. Compared to the case study1, the same level of participation was observed in the class.

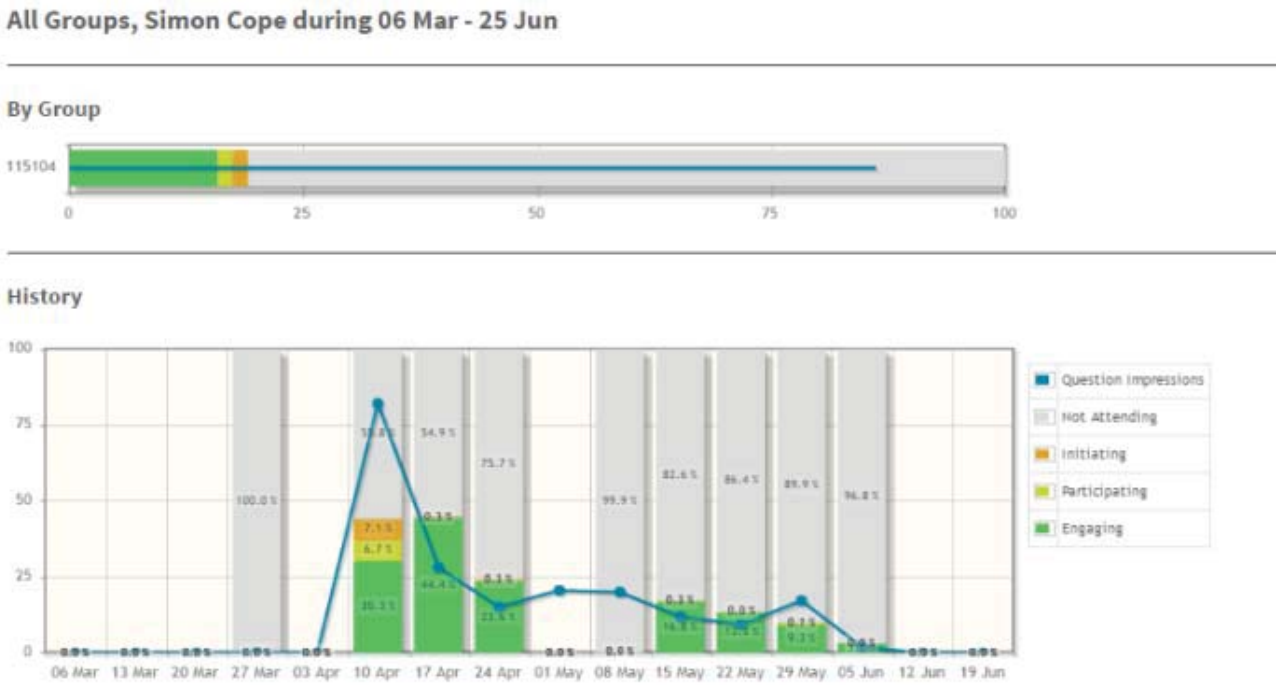

Figure 4: Engagement history case study 2

3.4.4 Survey Analyses

We also ran a survey questionnaire at the end of the class to gauge students' satisfaction on the impact of using audience participation tool (Xorro-Q) in their learning process and interest in the course. The percentage of students' participation has been depicted in Figure 5.

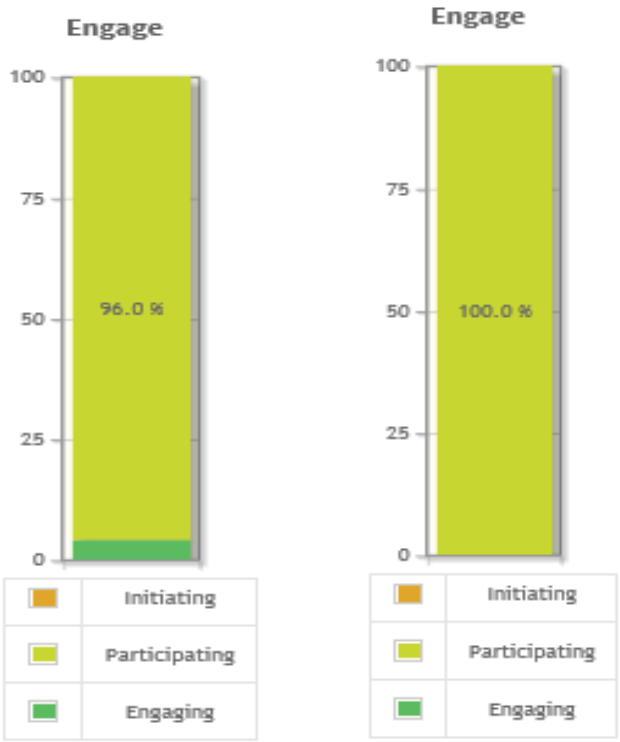

Figure 5: percentage of students' participation in case study 1 and 2

We asked students what their general impression was regarding the questions asked through Xorro-Q during the class? The analysis in the form of percentage has been shown in Table 1.

Table 1: Students' general impression regarding using the tool

	Case study one	Case study two
I enjoyed it	51.78%	42%
It was OK	41.07%	50%
I have no opinion as such	7.14%	0%
It was a waste of time	0%	7.14%

Average agreement with general impression regarding asking questions during the class using Xorro-Q was calculated for the two classes. (It was a waste of time=1; I enjoyed it=4) The average satisfaction for case study 1 was 3.95 and for case study 2 was 3.28. We can understand that students in case study 1 were more satisfied to use Xorro-Q. But it was just substantial degree of differences and not overwhelming with the second case study.

Then we asked students how easy it was to use Xorro-Q software? The analysis in the form of percentage has been shown in Table 2.

Table 2: Students' impression regarding the ease of working with the tool

	Case study1	Case study2
Very easy	69.64%	57.14%
I worked it out	25%	42.86%
Not intuitive	5.23%	0%
Very hard	0, 0%	0%

When we calculate the average agreement with regards to the ease of use, the average for case study 1 was 3.64 and 3 for case study 2. Respectively it shows students in the first case study felt that working with the tool was easier compared with the students in case study 2.

When we asked whether students thought that by using the technique of asking questions through Xorro-Q, we can help them in the process of learning, they had different responses illustrated in Table 3.

Table 3: Students impression regarding the effectiveness of tool

	Case study 1	Case study2
A lot	17.86%	0%
Somewhat	69.64%	78.57%
A little	10.71%	14.28%
Not at all	1.78%	7.14%

Students in the case study 1 with the average agreement of 3.04 believed that the tool helped them more compare the average agreement of 2.71 in case study 2.

In case study 1 where the questions did not have correct or wrong answers, students thought asking questions through Xorro-Q helped them more in the process of learning. In this question, the two groups had a more similar opinion regarding helpfulness of the tool in the process of their learning compared to other questions.

Students were asked asking questions through Xorro-Q, had impacted on their interest in the course. Their responses regarding this question are illustrated in Table 4.

Table 4: the impact of using the tool on students' interest

	Case study 1	Case sstudy2
A lot	32.14%	7.14%
Somewhat	50%	57.14%
A little	16.07%	7.14%
Not at all	1.78%	28.57%

The average agreement for students regarding the effect of Xorro-Q as regards an increase in the level of interest is 3.125 and 2.42 for case study 1 and case study 2 respectively.

Students in the case study 1 who had discussion questions thought that asking questions with Xorro-Q increased their interest. The difference between students idea increased.

We also asked the students whether they thought answering questions using Xorro-Q made them more attentive and kept them engaged in class as shown in Table 5. The students in case study 1 have an average score of 3.16 regarding whether asking questions through Xorro-Q made them more attentive and engaged them in the class compared to case study 2 with an average score of 2.43. One

more time it is shown that students in case study 1 thought that using Xorro-Q for answering questions made them be more engaged and attentive in the class.

Table 5: Students' responses about their engagement in the course

	Case study 1	Case study2
A lot	35.71%	7.14%
Somewhat	48.21%	50%
A little	12.5%	21.43%
Not at all	3.57%	21.43%

In addition, they were asked that whether it helped them to learn better when they compared their results with other students' results when it was shown on the board as depicted in Table 6.

Table 6: Students' responses regarding comparing their results

	Case study 1	Case study 2
A lot	46.43%	21.43%
Somewhat	39.29	42.86%
A little	12.5%	0%
Not at all	1.78%	35.71%

We saw the maximum discrepancy between the two groups' ideas regarding how this helped them when they compared their results on the board with other classmates'. The average agreement for case study 1 was 3.30 and for case study 2 was 2.5. Again students in case study 1 thought that when they compared the results with the ones of other students, it helps them to learn more.

Both classes had positive attitudes regarding using Xorro-Q but comparing these two groups we identified that students in case study 1 where teacher used discussion questions had a more positive attitude regarding using Xorro-Q.

We also asked them how it felt for them to see their answers displayed to everyone to see as shown below in Table 7.

Table 7: Students' feelings about displaying their answers

	Case study 1	Case study 2
I enjoy it	28.57%	14.28
It motivates me	30.36%	42.85
It makes me more attentive	39.28%	57.15
I find it scary	12.5%	7.14

This was the only time that students in case study 2 had a more positive attitude regarding their answers displayed to everyone compared to case study1. The average agreement for case study 1 was 2.96 and for case study 2 was 3.07. It is interesting that students in both groups thought that since the answer was displayed on the board for everyone they were more attentive.

Both of the courses were from the School of Business but in case study 1 the kind of questions asked through the tool were mostly discussion questions compared to the case study 2 where questions were multiple choice. The teacher in case study 2 always went through the questions that students answered and talked about what portion of the class got it right or wrong. Results showed that students enjoyed discussion questions more compared to multiple choice questions.

When we asked that how they liked to see themselves displayed on the board, students had different answers. The majority of students preferred to be anonymous or they chose to be identified through their IDs when the results were shown on the board instead of showing their names.

Based on our data, students in case study 1 always had more positive ideas regarding using Xorro-Q in their classes. The only time case study 2 showed slightly more positive compared to the case study 1 was when they were asked about their feelings when they saw their answers on the board and so could everyone else.

Between all questions we asked students, the best positive answer for the case studies were given to the students' general impression regarding using the tool in their classes. The maximum differences between two groups were about the time they were asked to tell us what they learned when they compared the results on the board against those of other students'.

It is also interesting that although the students in case study 1 thought they learned more when they compared their results with those of other students on the board, they did not enjoy it. The minimum differences between the results were noticed when we asked whether the tool helped them in the process of learning.

Even if they thought that answering questions through Xorrro-Q made them more attentive, engaged, and increase their interest they did not want to see their names on the board.

There were also some open-ended questions in our survey instrument. Students' answers to open-ended questions showed that students generally had positive feedback towards using audience interaction tools in classes. Students were asked about their most and least favorite feature in Xorro-Q.

According to the students' responses there were different reasons for each group to like the tool. In case study 1 the following quotations were given by students regarding what they like about Xorro-Q. All of the students who wrote their opinion about asking questions through Xorro-Q had a positive feedback for using Xorro-Q in case study 1 and they likes the

"*ease of use, interactivity, interesting to see the opinions of the class, Different, it was different and new, Interactive, Quick, Practical, Interactive, Kept me paying attention and helped me know how much I understood, It involves everyone, Seeing others opinions, It helped me pay attention to what we were learning and engaged me in the lecture, Easy, makes us more attentive in class, breaks up the teacher talking for a whole 3 hrs", ,Seeing others answers, seeing everyone else's answers. How it let us be interactive, Quick, fun, Interactive, interesting, Easy to access and answer, Usable, yes, good, Interactive, dont know, yeap, Good, Your opinion is heard without being put on the spot and you can see what there are thinking too which is intriguing, It's interesting. More fun, Nice to be able to interact*

with lecturer and other students in a large class without having to talk or yell at each other, good, Style, Answers are displayed so makes you pay attention, interesting, video, interactive learning"

In case study 2 when the teacher asked from students that what did you like about the tool (Xorro-Q) that we used in the class? All the students except 13.98% of the students in case study 2 gave us positive feedback regarding using the tool in their class. Followings are the students' quotations regarding what do they like about the tool.

"*Questions that may be useful, easy to use, simple to understand, Ease of use and it provided variety to the lectures, simple to understand, Ease of use and it provided variety to the lectures, It was good for engaging the class prior to getting into the topic. Something fun, but relevant that prepared us for what was likely to be ahead in the lecture, Gave us a challenge, Nothing at all. It actually put me off the whole paper, Although the format of the questions were similar to pre and post chapter quizzes enjoyed them as the Xorro-Q was an additional tool I was able to use in my learning process, Motivator, It was easy to use, It helped review previous concepts learnt. It was also engaging, It helped the lecture to be more interactive and interesting ,Sometimes didn't work, It took too long to wait for answers, ,"No device, no participation", no, You cannot come back and change the answer, Technical issues, need to login every time, I wasn't uploaded on it for a few lectures then we didn't use it in many lectures, nothing, ,I didn't have any issues with it, It was hard to setup, Being compared with other students on a big screen is demotivating, When i didn't bring any device, all good, All good, If it displayed names / IDs - would prefer anonymous, good, ,shot answer questions,":)", Nothing, god, When it used specific student names*"

3.5 CONCLUSION AND FUTURE WORK

In this study the use of audience interaction tool has been investigated in two undergraduate courses. The aim was to examine how using this tool could help students in the process of their learning, and keep them engaged and interested during class. This study drawing on activity theory looked at the engagement of students in two undergraduate courses. Applying the elements of the activity theory to our classroom settings, we found that audience participation tool has a promising direction for engaging students in the process of teaching and learning. The tool has proved to be effective in providing new insights to lecturers, students, and the institution, and has potential to help all the

parties involved so that the right decisions are made regarding the efficacy of the teaching and learning, and the evaluation process.

Self-report measures indicate that students enjoy a more participatory approach to in-class teaching and learning. This is consistent with a number of theories relating to student motivation. However, can we be assured that highly motivated learners using participation will be able to achieve better outcomes?

Returning to the case study, it seems that a useful path forward would be to find a way to monitor and combine subject, self-report measures of whether a student feels that they are learning and achieving with external measures of success. By intervening early in a class, teachers can ensure that students have the best chance of success. Technologies which increase participation need to be developed on conjunction with learning analytics platforms that can rapidly interpret a wide range of data and provide instantaneous feedback to students.

For our future study, we need to be able to link together student participation with outcomes, to be able to predict individual performance, as well as monitor whole of class (and whole of institution) outcomes. One approach to this would be to utilize learning analytics.

3.6 REFERENES

Ali, Liaqat, Hatala, Marek, Gašević, Dragan, & Jovanović, Jelena. (2012). A qualitative evaluation of evolution of a learning analytics tool. *Computers & Education, 58*(1), 470-489.

Ames, Carole, & Archer, Jennifer. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of educational psychology, 80*(3), 260.

Arnold, Kimberly E, & Pistilli, Matthew D. (2012). *Course signals at Purdue: using learning analytics to increase student success.* Paper presented at the Proceedings of the 2nd International Conference on Learning Analytics and Knowledge.

Baker, Ryan SJD, & Yacef, Kalina. (2009). The state of educational data mining in 2009: A review and future visions. *JEDM-Journal of Educational Data Mining, 1*(1), 3-17.

Bandura, Albert. (1986). Social foundations of thought and action: A social cognitive theory.

Beekes, Wendy. (2006). The 'millionaire'method for encouraging participation. *Active learning in higher education, 7*(1), 25-36.

Black, Erik W, Dawson, Kara, & Priem, Jason. (2008). Data for free: Using LMS activity logs to measure community in online courses. *The Internet and Higher Education, 11*(2), 65-70.

Brown, Ann L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The journal of the learning sciences, 2*(2), 141-178.

Chickering, Arthur W, & Gamson, Zelda F. (1987). Seven principles for good practice in undergraduate education. *AAHE bulletin, 3*, 7.

Collins, Allan, Joseph, Diana, & Bielaczyc, Katerine. (2004). Design research: Theoretical and methodological issues. *The journal of the learning sciences, 13*(1), 15-42.

Corrin, Linda, & de Barba, Paula. (2014). *Exploring students' interpretation of feedback delivered through learning analytics dashboards.* Paper presented at the Proceedings of the ascilite 2014 conference.

Credé, Marcus, & Phillips, L Alison. (2011). A meta-analytic review of the Motivated Strategies for Learning Questionnaire. *Learning and Individual Differences, 21*(4), 337-346.

Cue, Nelson. (1998). *A universal learning tool for classrooms.* Paper presented at the Proceedings of the First Quality in Teaching and Learning Conference.

Dearn, JM. (1996). *Enhancing the first year experience: creating a climate for active learning.* Paper presented at the Proceedings of the Second Pacific Rim Conference on the First Year in Higher Education Transition to Active Learning, University of Melbourne.

Dollár, Anna, & Steif, Paul S. (2012). Web-based statics course with learning dashboard for instructors. *Proceedings of computers and advanced technology in education (CATE 2012)*.

Dörner, Dietrich. (1996). The logic of failure: Why things go wrong and what we can do to make them right.

Draper, Stephen W, Cargill, Julie, & Cutts, Quintin. (2002). Electronically enhanced classroom interaction. *Australasian Journal of Educational Technology, 18*(1).

Engeström, Yrjö. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of education and work, 14*(1), 133-156.

Feryok, Anne. (2012). Activity theory and language teacher agency. *The Modern Language Journal, 96*(1), 95-107.

Fritz, John. (2010). Video Demo of UMBC's" Check My Activity" Tool for Students. *Educause Quarterly, 33*(4), n4.

Gardner, John W. (1995). *Self-renewal: The individual and the innovative society*: WW Norton & Company.

Georg, Geri, & France, RB. (2013). An Activity Theory Language: USE Implementation. *Colorado State University Computer Science Department Techn. Report, CS-13-101, http://www.cs.colostate. edu/TechReports/Reports/2013/tr13-101. pdf (acc*.

Govaerts, Sten, Verbert, Katrien, Duval, Erik, & Pardo, Abelardo. (2012). *The student activity meter for awareness and self-reflection.* Paper presented at the CHI'12 Extended Abstracts on Human Factors in Computing Systems.

Hasan, Helen. (1999). Integrating IS and HCI using activity theory as a philosophical and theoretical basis. *Australasian Journal of Information Systems, 6*(2).

Hattie, John, & Timperley, Helen. (2007). The power of feedback. *Review of educational research, 77*(1), 81-112.

Kober, Nancy. (2015). *Reaching Students:: What Research Says About Effective Instruction in Undergraduate Science and Engineering*: National Academies Press.

Lantolf, James P, & Appel, Gabriela. (1994). *Vygotskian approaches to second language research*: Greenwood Publishing Group.

Lantolf, James P, Thorne, Steven L, & Poehner, Matthew E. (2000). Sociocultural theory and second language development.

Littauer, Raphael. (1972). Instructional Implications of a Low-Cost Electronic Student Response System. *Educational Technology: Teacher and Technology Supplement, 12*(10), 69-71.

Mazza, Riccardo, & Milani, Christian. (2004). *Gismo: a graphical interactive student monitoring tool for course management systems.* Paper presented at the International Conference on Technology Enhanced Learning, Milan.

McConnell, Jeffrey J. (1996). Active learning and its use in computer science. *ACM SIGCSE Bulletin, 28*(SI), 52-54.

McKeachie, Wilbert J. (1990). Research on college teaching: The historical background. *Journal of educational psychology, 82*(2), 189.

Meece, Judith L. (2001). *Child and Adolescent Development for Educators with Free Making the Grade*: McGraw-Hill Humanities, Social Sciences & World Languages.

Paris, Scott G, & Oka, Evelyn R. (1986). Children's reading strategies, metacognition, and motivation. *Developmental Review, 6*(1), 25-56.

Park, & Farag. (2015). Transforming the Legal Studies Classroom: Clickers and Engagement. *Journal of Legal Studies Education, 32*.

Pintrich, Paul R. (1988). A process-oriented view of student motivation and cognition. *New directions for institutional research, 1988*(57), 65-79.

Pintrich, Paul R. (2000). An achievement goal theory perspective on issues in motivation terminology, theory, and research. *Contemporary educational psychology, 25*(1), 92-104.

Pintrich, Paul R, & De Groot, Elisabeth V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of educational psychology, 82*(1), 33.

Preszler, Ralph W, Dawe, Angus, Shuster, Charles B, & Shuster, Michèle. (2007). Assessment of the effects of student response systems on student learning and attitudes over a broad range of biology courses. *CBE-Life Sciences Education, 6*(1), 29-41.

Proceedings of the 1st International Conference on Learning Analytics and Knowledge. (2011). Banff, Alberta, Canada.

Ravishankar, J, Epps, J, Ladouceur, F, Eaton, R, & Ambikairajah, E. (2014a). *Using iPads/Tablets as a teaching tool: Strategies for an electrical engineering classroom.* Paper presented at the International Conference on Teaching, Assessment and Learning (TALE).

Ravishankar, J, Epps, J, Ladouceur, F, Eaton, R, & Ambikairajah, E. (2014b). *Using iPads/Tablets as a teaching tool: Strategies for an electrical engineering classroom.* Paper presented at the Teaching, Assessment and Learning (TALE), 2014 International Conference on.

Santos, Jose Luis, Govaerts, Sten, Verbert, Katrien, & Duval, Erik. (2012). *Goal-oriented visualizations of activity tracking: a case study with engineering students.* Paper presented at the Proceedings of the 2nd international conference on learning analytics and knowledge.

Santos, Jose Luis, Verbert, Katrien, Govaerts, Sten, & Duval, Erik. (2013). *Addressing learner issues with StepUp!: an Evaluation.* Paper presented at the Proceedings of the Third International Conference on Learning Analytics and Knowledge.

Saroyan, Alenoush, & Snell, Linda S. (1997). Variations in lecturing styles. *Higher Education, 33*(1), 85-104.

Sibley, Jim, & Spiridonoff, Sophie. (2010). What is TBL? *Retrieved February, 23*, 2011.

Singer, Susan, & Smith, Karl A. (2013). Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering. *Journal of Engineering Education, 102*(4), 468-471.

Valsiner, Jaan. (2007). Culture in minds and societies: Foundations of cultural psychology. *Psychol. Stud.(September 2009), 54*, 238-239.

Van Lier, Leo. (2002). An ecological-semiotic perspective on language and linguistics. *Language acquisition and language socialization: Ecological perspectives*, 140-164.

Verbert, Katrien, Duval, Erik, Klerkx, Joris, Govaerts, Sten, & Santos, José Luis. (2013). Learning analytics dashboard applications. *American Behavioral Scientist*, 0002764213479363.

Verbert, Katrien, Govaerts, Sten, Duval, Erik, Santos, Jose Luis, Van Assche, Frans, Parra, Gonzalo, & Klerkx, Joris. (2014). Learning dashboards: an overview and future research opportunities. *Personal and Ubiquitous Computing, 18*(6), 1499-1514.

Vygotsky, Lev Semenovich. (1980). *Mind in society: The development of higher psychological processes*: Harvard university press.

Waldrop, M Mitchell. (2015). The Science of Teaching Science. London, England: Nature Publishing Group Macmillan

Wang, & Hannafin. (2005). Design-based research and technology-enhanced learning environments. *Educational technology research and development, 53*(4), 5-23.

Weaver, Robert R, & Qi, Jiang. (2005). Classroom organization and participation: College students' perceptions. *The Journal of Higher Education, 76*(5), 570-601.

Wieman, Carl E. (2014). Large-scale comparison of science teaching methods sends clear message. *Proceedings of the National Academy of Sciences, 111*(23), 8319-8320.

Winne, Philip H. (2006). How software technologies can improve research on learning and bolster school reform. *Educational Psychologist, 41*(1), 5-17.

Zhu, Erping. (2007). Teaching with clickers. *Center for research on learning and teaching occasional papers, 22*, 1-8.

Zimmerman, Barry J. (2002). Becoming a self-regulated learner: An overview. *Theory into practice, 41*(2), 64-70.

Zimmerman, Barry J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Educational Research Journal, 45*(1), 166-183.

Zimmerman, Barry J, & Martinez-Pons, Manuel. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of educational psychology, 80*(3), 284.

Zimmermann, Barry J. (2001). *Theories of self-regulated learning and academic achievement: an overview and analysis. self-regulated learning and academic achievement: theoretical perspectives*: Zimmermann BJ ve Schunk, DH (edt). Mahwah, NJ, ABD.

Chapter 4

Clustering Students based on their participation in classes

Shadi Esnaashai

School of Engineering and

Advanced Technology

Massey University

Auckland, New Zealand

Email: S.Esnaasahri@massey.ac.nz

ABSTRACT

Increasing educational attainment from a broader and more diverse student population is a policy goal for many governments. Yet increased enrolments brings many challenges for faculty members trying to track and predict academic performance. One possible mechanism for prediction is to use in-class participation data to determine whether participation is linked to academic performance. In this study, we combined in-class and out-of-class (e.g., Learning Management System) data with a range of qualitative and quantitative self-report measures. We then used a range of data mining algorithms to predict final course outcomes. We found that students who participated more and thought that the tool helped them to learn, engaged and increased their interest in the course more, and eventually achieved the highest scores. This finding supports the view that in-class participation is critical to learning and academic success.

Keywords

Learning analytics, clustering, audience participation tool

4.1 INTRODUCTION

The number of students with different needs enrolled in university courses has risen. Some of these students, however, do not complete their course (Arnold & Pistilli, 2012; Davis; Gašević, Dawson, & Siemens, 2015). Given the status quo, faculty members wish to identify such students to give them feedback and encourage them to finish their courses. There is also a greater motivation for the New Zealand universities to identify the students who are at risk of failure so that the universities help those students in advance and prevent them from financial penalties which may apply if many students fail. A

useful way to identify these students so that university could help them is by doing a tracing and analysis of the data they have left out in their learning management tools.

Students' data related to students' reading, writing, test taking, and the performing of various tasks including communication with their peers will be collected by Learning Management Systems (LMS) records (Mostow et al., 2005). The amount of data generated by these systems is often too large. Therefore, teaching staff cannot get enough useful information out of the valuable data. One useful way to overcome this problem and achieve the goal is data mining (Zaïane & Luo, 2001).

Data mining (DM) has been used in different disciplines to predict future trends and the computer behavior (Ngai, Xiu, & Chau, 2009). The shift happens to decisions driven from the data and analytics in the clinical practice, business and government. But only recently the higher education systems are using the powerful analytic tools.

Educational data mining (EDM) has emerged to understand student learning experiences from various data gathering systems by using digital footprint from students. EDM exploits statistical, machine learning and data mining algorithms over the gathered educational data. Educational data mining is sometimes referred to as learning analytics. Learning Analytics (LA) has emerged to discover the patterns in learning by using students' data and applying the data mining algorithms to give recommendations and feedback to students and teachers.

Many studies (Ayers & Junker, 2006; Chen et al., 2000; Cocea & Weibelzahl, 2006; Grudnitski, 1997; Hämäläinen & Vinni, 2006; Kotsiantis & Pintelas, 2005; Minaei-Bidgoli & Punch, 2003; Pistilli & Arnold, 2010; Pokay & Blumenfeld, 1990; Ransdell, 2001; Talavera & Gaudioso, 2004; Ting & Man, 2001) using educational data mining algorithms have been conducted which aim to identify at risk students by predicting students' course outcome, for example, from their forum activities, content request, and time spent online. None of these studies used the participation of students in the class to predict the course outcome of the students in spite of their emphasis on the importance and positive effects of interaction in class (Chickering & Gamson, 1987; Fulford & Zhang, 1993; Kearsley, 1995; Kumari, 2001; Stubbs et al., 1976). This study addresses the gap by clustering the students' course outcome using weekly student data from class participation.

The importance of participation of students in class has been emphasized (Chickering & Gamson, 1987; Dearn, 1996; Kober, 2015; McConnell, 1996; Sibley & Spiridonoff, 2010; Singer & Smith, 2013); and it has

been stated that students need to participate in group activities in class to learn more. A large number of empirical studies affirm that students learn better when they tackle questions in class rather than passively listen to answers (Waldrop, 2015). Studies also suggest that students retain more subject knowledge and their scores could improve by 20% when they engage in discussions during classes (Dörner, 1996; Wieman, 2014).

To date, different techniques and technical tools have been used to improve participation and enhance learning (Park & Farag, 2015; Ravishankar et al., 2014a, 2014b). In this study we used Xorro-Q and Stream to collect student's participation data. Whenever students engaged with audience participation tool (Xorro-Q), the students' digital foot print data has been collected. The goal was to understand how using the tool affects participation of students in their classes and consequently on their course outcome.

In the literature there are different kinds of tools collecting the data from students' activities in their classes. A very large set of data also will be collected from the educational software and online learning systems. This enables the researchers to use the data to mine them so that they find out about the learning process of the students. There are different studies applying educational data mining algorithms on the data from learning management systems to identify at risk students. In this study after students' participation data were collected by the tools, clustering was used to understand whether the data collected through audience participation tool and Stream could help to cluster the students based on their course outcome. The purpose of this study was to model students' activities in their classes. To find similar learning behaviors, clustering of students is a proper way. We grouped the students based on their activities in the class using clustering algorithms to group the students and find profile of their behaviors.

4.2 LITERATURE REVIEW

In this section an overview of the educational data mining, learning analytics and the gap in the field are discussed. In addition, the technologies which have emerged to help the students and the lecturers to understand the process of learning are explained.

4.2.1 Educational Data Mining

In this section, an overview of the Educational data mining (EDM) methods mostly used by EDM community is given (Ryan Shaun Baker & Inventado, 2014). Although there are other techniques and

algorithms available to do EDM, an overview is given on the methods mostly used by the EDM community.

4.2.1.1 Prediction methods

In the prediction, a model will be developed by which prediction will be done for a dependent variable from the combination of independent variables. Classification and regressions are two of the most important types of prediction models.

4.2.1.1.1 Classification

In this method, the prediction would be either a binary or categorical variable based on the value of other attributes. For example, classification of the students will be made through similar marks based on the activities they have done in-class through audience participation tool and out-of-class through Stream. Decision trees, step regression, logistic regression, and Bayesian are the most important algorithms in this category.

4.2.1.1.2 Regression

In this model the predicted variable is a continuous variable. The model produced from this algorithm is like the linear regression models in statistics. Neural network is one of the most important algorithms in this category. In this model the goal is to find out how activities of students in the course can predict the course outcome of the students. For example, in this study each student has a sequence of activities in the class and out of the class, the goal is how and which independent variables (different activity types) can predict the dependent variables (course outcome) for the students.

4.2.2.2 Relationship mining

The goal for relationship mining is to find the relationship between variables in the data set. In this model, it can be identified which variable has a strong association with another single variable or which variables have the strongest relationship with the dependent variable.

4.2.2.2.1 Association rule mining

The goal for association rule mining is to find a set of IF-then rules out of the data. Then based on the rules it is possible to specify the value for the unknown variables. Rules are a simple way of presenting knowledge. For example, in this study the goal is to generate the rules which can categorize the students based on their activity levels in the class.

4.2.2.3 Structure discovery

In structural discovery algorithm, the goal is to find a structure in the data. There is no need to have access to prior idea about what to find in the data. There is also no need to have ground truth. In this category clustering will be used.

4.2.2.3.1 Clustering

The goal for clustering is to find data that group together naturally. In this way the data set will be divided into a set of clusters. In this part, students can be clustered based on the number of correct answers to questions in each activity per week questions. Then it is possible to find out co-efficiencies for different themes. It is also possible to cluster the data based on the course materials they have used or the amount of data they have downloaded and clustered depending on how much forum activity they have had.

4.3 Learning Analytics

Learning analytics (LA) is defined according to the 1st International Conference on Learning Analytics and Knowledge (*Proceedings of the 1st International Conference on Learning Analytics and Knowledge*, 2011) as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs".

There are differences between EDM and LA but there are some common interests between them. For example, "both follow in data-intensive approaches to education research, and share the goal of enhancing educational practice." However, EDM is concerned with the analysis of large scale educational data, with a focus on automated methods. LA usually largely focuses on the interpretation of data and visualization by humans (Ryan Shaun Baker & Inventado, 2014).

Horizon Report 2011 (Consortium, 2011) mentioned that learning analytics is an emerging technology, which in the next years can have impact on higher education. There is another division in addition to learning analytics called academic analysis which is not as specific compared to learning analytics. Academic analysis reflects more on the role of data analysis at an instructional level compared to learning analysis which reflects more on the learning process. In learning analytics, the data will be interpreted in terms of learning. It is important how we interpret the learning process. The output of

learning analytics spans the activities in higher education which could affect the university administrators' decision, teachers' decisions on learning and teaching, and students' success (Ryan SJD Baker & Yacef, 2009; Black et al., 2008; Hattie & Timperley, 2007).

There are different dashboard applications developed to address these needs and support learning and teaching support. These dashboards represent the graphical view of the current and historical data from the students, the teacher, and the content. This information can be used by the teacher, the students, and the university (Verbert et al., 2013; Verbert et al., 2014). In the following section an overview of different dashboards which were developed to address these needs and support learning and teaching is given.

4.3.1 Learning analytics dashboard

Learning analytics dashboard itself is an application which can show the behavior of students in learning environments. This application uses students' data regarding their participation in the log files, class activities, assignments, and mine the data to find a meaningful pattern out of that and visualize it in a way that the information is comprehensive at a glance.

For example, a graphical interactive student monitoring and tracking system tool (GISM) was developed which extracted tracking data from a course management system for an online course. This tool is capable of providing the teachers with information about their course and students in the class to provide a better support for the learner (Mazza & Milani, 2004).

LOCO_Analyst is a dashboard for teachers. This tool provides the feedback for teachers regarding activities and students' performance in the activities. It shows the pattern of student learning and shows the result of self-assessments. This is one of the rare tools which have been evaluated (Ali et al., 2012).

It is also important to give information to students about their learning process to help them in their learning process and increase their motivation. For example, Santos et al. (2012) develop a dashboard which reflects students' activity in the courses and enables them to compare their results and achievements with other peers.

StepUp (Santos et al., 2013) is another dashboard which was designed to support awareness, self-reflection, sense making, and impact on learners. This tool targets both learners and their teachers in providing visualized data which reflects on the process of teaching and learning.

Course Signal is a dashboard for students. It can predict the students' outcome and visualize the data regarding students' grades, the amount of time students have spent on each task and their past performance. The student will receive traffic signal which could be red, green, or yellow based on how far it is from the threshold. Faculty members can also send personalized email to students based on the performance of the students in that specific course and can refer the students to different resources (Arnold & Pistilli, 2012).

Carnegie Mellon University (Dollár & Steif, 2012) has another dashboard for students called OLI. In their design they show whether the student meets their goal for the course or not. It shows the information regarding different courses for the students. The students can compare their achievement in different courses.

Student Activity Meter (SAM) is another dashboard which provides visualization for the students and their teachers (Govaerts et al., 2012). It shows the pattern on engagement of student, and resource usage in Moodle over time.

In the University of Maryland, Baltimore County the researchers invented a tool called Check My Activity (Fritz, 2010); in this tool the learner compares its own activity with other anonymous students. This can help the students to know themselves better by providing them with information. The teacher also could use this information and give feedback and suggestions to students. A comparison of available dashboards based on information in dashboard, target users and their evaluation is given in Table 1.

Table 4: Comparison of available dashboards

Name of the tool	Information in dashboard	Target	Evaluation
GISM	Login access, content usage, message analysis	Teachers	Evaluation of the graphical representation
Course Signal	Time spent, social interaction, content usage, performance result, message analysis	Students	Effectiveness, usability, usefulness
LOCO_Analyst	Time spent, social interaction, content usage, message analysis, performance results	Teachers	Usefulness and usability
StepUp	Time spent, social interaction,	Teachers and students	Usability and usefulness

	content usage		
OLI	Time spent, content usage	Teachers	Usefulness, usability
SAM	Time spent, content usage, message analysis	Teachers and students	Usability, usefulness
Check My Activity	Summary of the student activity, frequency of use against an anonymous summary of peers	Student	Usefulness

There has been much work on visualization on the results from learning analytics but there needs more to be done. This visualization works as feedback for teachers, students and universities. Therefore, it needs to be well studied so that it can give instructional feedback to them. For example, Corrin and de Barba (2014) studied the dashboard design to find out how different students interpret the visualized data differently. They discussed how good students' performance would lower when the good students compared their performance with their peers and realized that they had outperformed their peers. Therefore, it is recommended to consider the instructional design and learning theories when designing new dashboards.

Most of the designs in learning analytics focus on the prediction for students' outcome. Term prediction in this study means using statistical techniques and data mining algorithms on the observation to characterize the model. In many academic disciplines prediction has been made on the students' performance data (Grudnitski, 1997; Pokay & Blumenfeld, 1990; Ransdell, 2001; Ting & Man, 2001). Different data mining techniques have been used in EDM to make predictions. For example, Hämäläinen and Vinni (2006) compared different machine learning algorithm methods to predict success in the course. Romero, Ventura, Espejo, and Hervás (2008) used data mining algorithm to classify students' final marks based on the use of Moodle. Neural network was also used to predict performance from test scores using back propagation and counter propagation (Fausett & Elwasif, 1994). Bayesian network has been used to predict the final exam performance based on the students' online activity with online tutor (Ayers & Junker, 2006). Rule based systems using genetic algorithm have been used for predicting final grade based on feature extracted from log data (Minaei-Bidgoli & Punch, 2003). Regression techniques have been used to predict student final performance based on the data from log and test scores in web based instructions (Talavera & Gaudioso, 2004).

Table 5- A summary comparison of different techniques

Paper	**Method**	**Output**
(Pinninghoff Junemann, Salcedo Lagos, & Contreras Arriagada, 2007)	Neural networks	Prediction for students' achievement in reading, math, and science courses
(Bresfelean, 2007)	Decision tree	To identify which students are likely to

		continue their studies
(Kabra & Bichkar, 2011)	Decision tree	Student performance
(Kotsiantis & Pintelas, 2005)	Regression techniques	Predicting final grades
(Pistilli & Arnold, 2010)	Discriminate function analysis (correct it)	Predict students' performance
(Cocea & Weibelzahl, 2006)	Decision tree	Finding low motivated students
(Chen et al., 2000)	Decision tree and data	To discover similar characteristics of the potential student group
(Talavera & Gaudioso, 2004)	Regression techniques	Predict student final performance
(Minaei-Bidgoli & Punch, 2003)	Genetic algorithm	predicting final grade
(Ayers & Junker, 2006)	Bayesian network	Predict final exam performance

(Fausett & Elwasif, 1994)	Neural network	Predict final performance
(Romero et al., 2008)	Statistical Classifier, Decision Tree, Rule Induction, Fuzzy Rule Learning, Neural Networks	Classifying students
(Hämäläinen & Vinni, 2006)	Multiple linear regression, support vector machines and three variations of naive Bayes classifiers	Prediction for course success

Classification has been used to discover similar characteristics of the potential student group (Chen et al., 2000) and identify low motivated students in order to help them not to drop out (Cocea & Weibelzahl, 2006) and use discriminant function analysis (Pistilli & Arnold, 2010). Predicting final grades using regression techniques has been used by researchers (Kotsiantis & Pintelas, 2005). Kabra and Bichkar (2011) used decision trees in educational data mining on engineering students' past performance data to generate the prediction for students' performance. Bresfelean (2007) used decision tree algorithms to identify which students are likely to continue their studies.

Neural networks have been used to predict students' achievements based on their data such as family, social and wealth characteristics. The prediction was for students' achievement in reading, math, and science courses (Pinninghoff Junemann et al., 2007).

Lykourentzou, Giannoukos, Mpardis, Nikolopoulos, and Loumos (2009) compared three feed-forward neural networks to predict final grades of students. Their results showed that neural networks achieved higher correlation while their error was approximately half of the linear regression error. Sheel, Vrooman, Renner, and Dawsey (2001) compared neural networks and statistical modelling to cluster students into two groups. They used the data from a single mathematical placement test. In Table 5 a summary comparison of different techniques used by different researchers is given.

4.4 METHODS

This study was run in two undergraduate courses at a New Zealand university. The first source of data regarding students' participation was gathered through audience participation tool (Xorro-Q). The data generally focuses on the number of questions students have answered in and particularly the number of correct answers in each week of the class.

Xorro-Q is a real-time audience participation tool which can be used for in-class assessments as well as for non-assessed engagements such as brainstorming, and concept questioning. In this study Xorro-Q was used by the teacher to run activities in the class. The students participated in the activities through their internet enabled devices. The results of students' answers to the questions were collected by the Xorro-Q's server.

Data regarding out-of-class participation was gathered through Stream. Stream is a Virtual Learning Environment (VLE) which supports students in their studies. Stream acts as an online learning community for students. Students can access the latest news in their subject, study notes, recent journal articles, podcasts, online presentations, interactive exercises and activities, and tests and quizzes. Whenever a student uses Stream, trace data from that student was collected by Stream.

In order to have a quality data and not just collecting the number of students' clickings we also collected data through conducting a questionnaire at the end of the class through Xorro-Q to investigate students' perceptions in regards to using audience interaction technologies in classrooms. Running questionnaire through Xorro-Q at the end of the class was also used to find out how students themselves evaluate their learning. In the questionnaire students was asked to write in their own words how they describe their experience about participating in activities. This helped us to understand the students' thoughts regarding their learning process.

4.4.1 Study design

To address the question regarding the effect of participation on course outcome, data was collected through audience participation tool. Xorro-Q tool was used in two Marketing course in the School of Business in a New Zealand university. The tool was used for 12 weeks in the course to collect participation data from students. Students were international students. There is a mix of students from diverse backgrounds. The teacher asked questions of students through Xorro-Q on materials the teacher taught in the class in order to understand whether students understood the course. The questions were both open ended and multiple choices which allowed the teacher to understand if the students were able to get the core concepts.

The participation of students in lectures was monitored and reflected in their overall grade. The final grade for students consisted of the combination of two assessments based on the concepts of test and market analysis report, a presentation, and a comprehensive exam. At the end of the class a questionnaire was run. The data collected from the case studies provided us with the ability to do clustering based on their course outcome.

The engagement history of the lecturer in case study 1 is shown in Figure 1. The engagement history refers to how the engagement metrics has been changing over a specified interval of time. The chart describes what proportion of an audience (averaged as determined through the filters) is attending, initiating, participating or engaged.

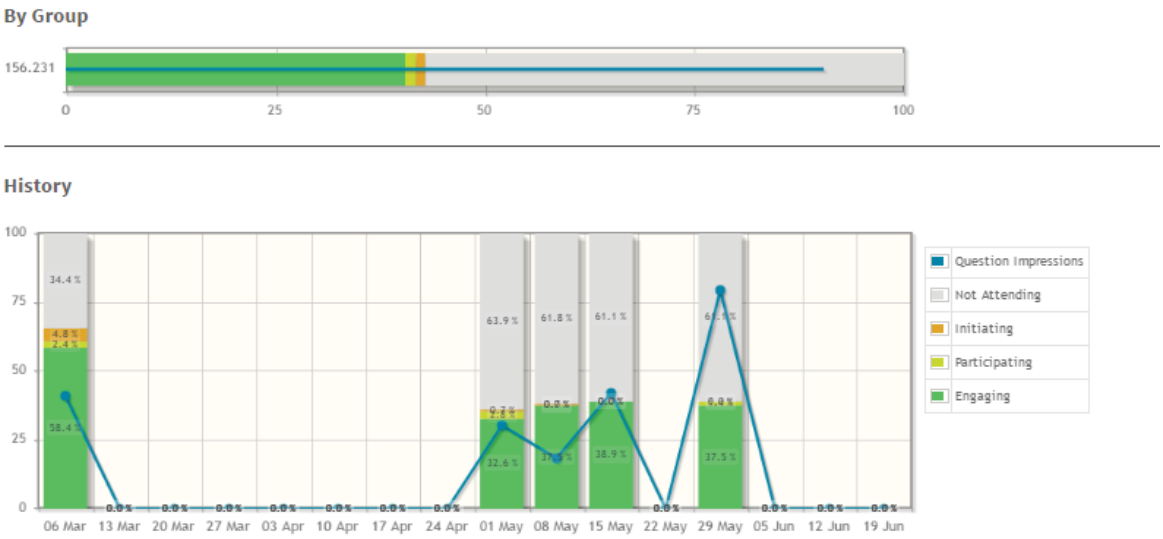

Figure 1: Engagement history case study 1

Figure 2 shows participation rate for the students and teacher activity for the duration of the course in case study 2. As the class was close to the end of semester, the participation of students reduced. Compared to the case study1, the same level of participation was observed in the class.

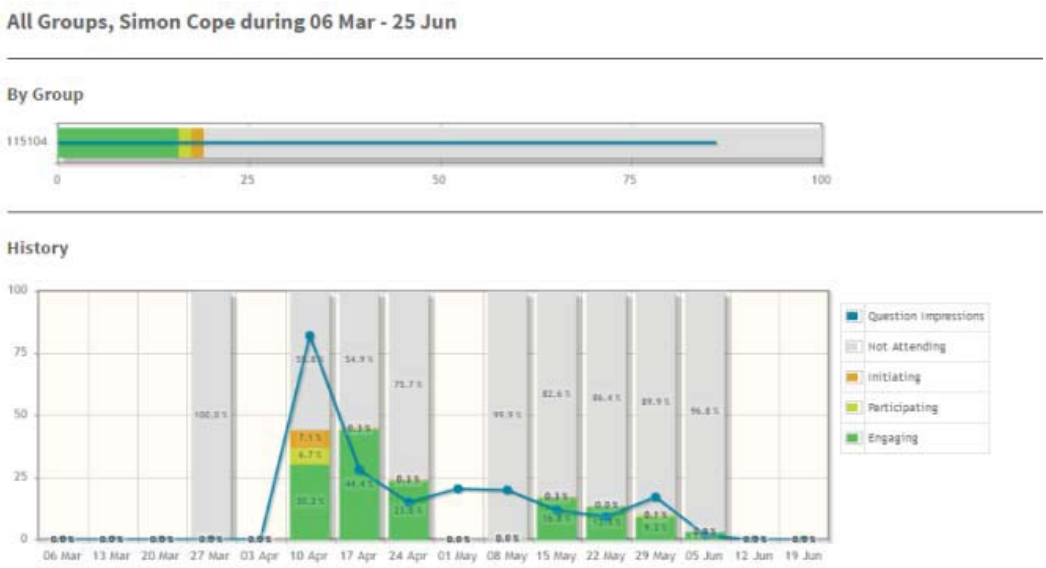

Figure 2: Engagement history case study 2

At the end of the class, we ran a questionnaire. We asked students what their general impression was regarding the questions asked through Xorro-Q during the class? In Case Study 1, 51.78% of the students “Enjoyed it”, 41.07% of students said “It was ok.”, 7.14% of them said they had no opinion as such and 0% believed “It was a waste of time”. For Case Study 2 in the same order students gave 42%, 50%, 0%, and 7.14% to each of the scales.

When we asked whether students thought that by using the technique of asking questions through Xorro-Q, we could help them in the process of learning, they had different responses. 17.86% of students in Case Study 1 believed, “It helped them a lot”, 69.64% believed the tool “Somewhat help them” and 10.71% believed the tool “Helped a little” and 1.78% believed that tool ‘Did not help at all”. In Case Study 2, 0% mentioned, “A lot”, 78.57% believed, “Somewhat” and 14.28% believed, “A little” and 7.14% “Not at all helped them”.

Students were asked if asking questions through Xorro-Q had impacted on their interest in the course. Their responses regarding this question shows that large portion of them i.e. 32.14% a lot, 50% somewhat, 16.07% a little, and 1.78% not at all" their interest had increased in the course. In Case Study 2, 7.14% said, "A lot", 57.14% said, "Somewhat". 7.14% said, "A little". 28.57% said, "Not at all".

We also asked the students whether they thought answering questions using Xorro-Q made them more attentive and kept them engaged in class. Their responses show that large portion of them i.e. 35.71% a lot, 48.21% somewhat, 12.5%a little, and 3.57% not at all" their attention and engagement were increased in the course. In Case Study 2, 7.14% said, "A lot", 50% said, "Somewhat". 21.43% said, "A little". 21.43% said, "Not at all".

In addition, they were asked that whether it helped them to learn better when they compared their results with other students' results when it was shown on the board. Their responses show that large portion of them i.e. 46.43% a lot, 39.29% somewhat, 12.5%a little, and 1.78% "not at all" thought the tool helped them to learn better when they compared their results with other students' results. In Case Study 2, 21.43% said, "A lot", 42.86% said, "Somewhat". 0% said, "A little". 35.71% said, "Not at all".

Average agreement with regards to the questions has been calculated for all the questions for two classes (we gave the minimum 1 to the most negative border and maximum of 4 to most positive border.

The average satisfaction for both Case Study 1 and Case Study 2 was always between 3 and 4. Based on that we can understand that students in both classes have positive attitudes regarding using the tool in the class. Based on the results, however, students in Case Study 1 always had more positive ideas regarding using Xorro-Q in their classes. The only time Case Study 2 appeared slightly more positive compared to the Case Study 1 was when they were asked about their feelings when they saw their answers and every else's on the board. Now that we know a large number of learners believed that participation is helpful for their learning (87.5% of students in Case Study 1 and 78.57% of students in Case Study 2 said that either it helped them a lot or somewhat help them). We intend to see whether or not data from their course outcome shows the same thing.

In our previous study (Esnaashari, Mathrani, & Watters, 2016) in our classroom settings we also applied the elements of activity theory as discussed by Engeström (2001). We found that audience participation tools have a promising direction for engaging students in the process of teaching and learning. However, engagement in the form of assessment is found to be higher, while engagement in the form of informal discussions may have less student participation, but, is considered more enjoyable. The data collected through our tool also showed that the class which adopted an activity-oriented approach rendered better results as far as enjoyment of students is concerned while traditional classes showed higher engagement. The tool has proved to be effective in providing new insights to lecturers, students, and the institution, and has potential to help all the parties involved so that the right decisions are made regarding the efficacy of the teaching and learning, and the evaluation process.

Self-report measures indicate that students enjoy a more participatory approach to in-class teaching and learning. This is consistent with a number of theories relating to student motivation. However, can we be assured that students who believed participation through the tool in class helped them to learn more and engaged more in the course will be able to achieve better outcomes?

To answer this question, we needed to be able to link together student participation with outcomes so that we could predict individual performance, as well as monitoring whole of the class (and the institution's) outcomes. For this purpose, we mapped students' questionnaire data to their final course outcome to see whether or not students believed that the effect of their participation on their course outcome reflects the course outcome. To do so we used clustering. In clustering we are categorizing unseen data without having knowledge about the classes of data at the stage of learning. In clustering, at the learning stage we will determine the classes in database. For the purpose of this study, we used K-Means clustering learning algorithm.

K-Means (Hartigan & Wong, 1979) is one of the simplest unsupervised learning algorithms. This algorithm follows a very simple way of classifying the data. The algorithm just needs a fixed prior number of clusters. There is one centroid available for each cluster. Based on the place of the centroids different results can be achieved. The centroids need to be as far from each other as possible. Then each point from a dataset will be associated to the nearest centroid. When all the points are associated to the centroids, the first stage of grouping is done. Based on the calculation, recalculation will be done

for calculating new K. The process of binding will be repeated for the new K centroid. After finishing this loop, the K centroids changed their location to a stage that there is no more changes to be done. It means that no more changes will be applied to the centroid. The optimal goal for this algorithm is to minimize the objective function which is squared error function. The objective function is as follows:

$$j = \sum_{j=1}^{n} \sum_{i=0}^{n} (x_i{}^j - c_j)^2$$

$(x_i{}^j - c_j)^2$ is a chosen distance measure between each data point and the centroid. The K-Means algorithms will be re-run multiple times to reduce the effect of randomly chosen centroids.

In this study when we collected the data, we did pre-processing and cleaning students' data to make students' data ready in order to be able to apply clustering in the data set. We used K-Means because it is a very simple algorithm and has been adapted to many problem domains. In our case we have n= 500 samples from the same class, and we know that they fall into k= 2 compact clusters, k < n. In the process mi is the mean of vectors in cluster i. Based on how well the clusters are spread, we use a minimum-distance classifier to separate them. For each x if || x - mi || is the minimum of all the k distances, then x belongs to cluster i. For K-Means, we guessed the initial m and used m to cluster the students. We continued this process until there was no changes in the mean and up until we reached k we replaced m with the means for each cluster.

The results of applying K-Means to our data have been shown in Figure 3. Cluster 1are those students who always participate, and Cluster 2 are those who stop participating from midterm. When we cluster the students in two groups, they have got two different averages in their final scores. The students who participate in class all the time have a higher score for their course outcome. The average for Cluster 1 is 80 and the average for Cluster 2 is 65.

Based on the model and evaluation for the score class attribute, we had 58% of students in cluster 1 and 42% of students in cluster 22.

Cluster#

Attribute	Full Data	0	1
Wk01	4.0	4.0	4.0
Wk02	4.0	4.0	4.0
Wk03	4.0	4.0	4.0
Wk04	6.0	6.0	6.0
Wk05	NULL	7.0	NULL
Wk06	NULL	4.0	NULL
Wk07	NULL	9.0	NULL
Wk08	NULL	17.0	NULL
Score	65.0	80.0	65.0

Figure3: Applying clustering on first dataset

We also applied K-Means with our second class of data that we had and again two clusters had two different averages. The clusters showed how students achieved better when they participated through the course and how they achieved lower when they disengaged from the tool and not participated in group activities in class. Students in Cluster 1 participated and had an average score of 16.1 out of 20. Students in Cluster 2 did not participate and had an average score of 13 out of 20 which is lower than that of Cluster one. The results have been shown in Figure 4.

Cluster#

Attribute	Full Data	0	1

Wk01	7.0	7.0	NULL
Wk02	NULL	6.0	NULL
Wk03	5.0	5.0	NULL
Wk04	5.0	5.0	NULL
Wk05	17	17	NULL
Score	14.4762	16.1	13

Figure4: Applying clustering on second dataset

Returning to the case studies, it seems that it was a useful path to find to monitor and combine subject, self-report measures of whether students feel that they are learning and achieving with external measures of success. By intervening early in class, teachers can ensure that students have the best chance of success. Technologies which increase participation need to be developed in conjunction with learning analytics platforms that can rapidly interpret a wide range of data and provide instantaneous feedback to students.

4.5 CONCLUSION

In this paper, we reported our study on clustering students based on their participation in group activities in class for the purposes of understanding and optimizing learning and the environments in which it occurs. To perform clustering, we chose K-Means clustering algorithm and clustered students into two groups for those who were participating and not participating in their group activities. This affirmed students' thinking that those who participated more and thought that the tool helped them to learn, engaged and increased their interest in the course got better scores.

The goal for us was to extract useful information for the teachers. Now that data showed the importance of participation in students' success and also showed students who participated in class activities all the time had a higher score in their final course outcome. The teachers can introduce

other interventions in the class to engage the students. By intervening early in class, teachers can ensure that students have the best chance of success.

4.6 REFERENCES

Aguiar, Everaldo, Ambrose, G Alex, Chawla, Nitesh V, Goodrich, Victoria, & Brockman, Jay. (2014). Engagement vs performance: Using electronic portfolios to predict first semester engineering student persistence. *Journal of Learning Analytics, 1*(3), 7-33.

Ali, Liaqat, Hatala, Marek, Gašević, Dragan, & Jovanović, Jelena. (2012). A qualitative evaluation of evolution of a learning analytics tool. *Computers & Education, 58*(1), 470-489.

Ames, Carole, & Archer, Jennifer. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of educational psychology, 80*(3), 260.

Arnold, Kimberly E, & Pistilli, Matthew D. (2012). *Course signals at Purdue: using learning analytics to increase student success.* Paper presented at the Proceedings of the 2nd International Conference on Learning Analytics and Knowledge.

Ayers, Elizabeth, & Junker, BW. (2006). *Do skills combine additively to predict task difficulty in eighth grade mathematics*.

Baker, Ryan Shaun, & Inventado, Paul Salvador. (2014). Educational data mining and learning analytics *Learning Analytics* (pp. 61-75): Springer.

Baker, Ryan SJD, & Yacef, Kalina. (2009). The state of educational data mining in 2009: A review and future visions. *JEDM-Journal of Educational Data Mining, 1*(1), 3-17.

Bandura, Albert. (1986). Social foundations of thought and action: A social cognitive theory.

Basharina, Olga K. (2007). An activity theory perspective on student-reported contradictions in international telecollaboration. *Language Learning & Technology, 11*(2), 82-103.

Beekes, Wendy. (2006). The 'millionaire'method for encouraging participation. *Active learning in higher education, 7*(1), 25-36.

Black, Erik W, Dawson, Kara, & Priem, Jason. (2008). Data for free: Using LMS activity logs to measure community in online courses. *The Internet and Higher Education, 11*(2), 65-70.

Bresfelean, Vasile Paul. (2007). *Analysis and predictions on students' behavior using decision trees in Weka environment.* Paper presented at the Information Technology Interfaces, 2007. ITI 2007. 29th International Conference on.

Brown, Ann L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The journal of the learning sciences, 2*(2), 141-178.

Campbell, John Patrick. (2007). *Utilizing student data within the course management system to determine undergraduate student academic success: An exploratory study*: ProQuest.

Chen, Gwo-Dong, Liu, Chen-Chung, Ou, Kuo-Liang, & Liu, Baw-Jhiune. (2000). Discovering decision knowledge from web log portfolio for managing classroom processes by applying decision tree and data cube technology. *Journal of Educational Computing Research, 23*(3), 305-332.

Chickering, Arthur W, & Gamson, Zelda F. (1987). Seven principles for good practice in undergraduate education. *AAHE bulletin, 3*, 7.

Cocea, Mihaela, & Weibelzahl, Stephan. (2006). Can log files analysis estimate learners' level of motivation?

Collins, Allan, Joseph, Diana, & Bielaczyc, Katerine. (2004). Design research: Theoretical and methodological issues. *The journal of the learning sciences, 13*(1), 15-42.

Consortium, New Media. (2011). The 2011 Horizon Report.

Corrin, Linda, & de Barba, Paula. (2014). *Exploring students' interpretation of feedback delivered through learning analytics dashboards.* Paper presented at the Proceedings of the ascilite 2014 conference.

Credé, Marcus, & Phillips, L Alison. (2011). A meta-analytic review of the Motivated Strategies for Learning Questionnaire. *Learning and Individual Differences, 21*(4), 337-346.

Creswell, John W, Hanson, William E, Plano, Vicki L Clark, & Morales, Alejandro. (2007). Qualitative research designs selection and implementation. *The counseling psychologist, 35*(2), 236-264.

Cue, Nelson. (1998). *A universal learning tool for classrooms.* Paper presented at the Proceedings of the First Quality in Teaching and Learning Conference.

Davis, Marsha. Identifying at Risk Students. *The 68th International Atlantic Economic Conference*.

Dawson, Shane. (2008). A study of the relationship between student social networks and sense of community. *Journal of Educational Technology & Society, 11*(3), 224-238.

Dearn, JM. (1996). *Enhancing the first year experience: creating a climate for active learning.* Paper presented at the Proceedings of the Second Pacific Rim Conference on the First Year in Higher Education Transition to Active Learning, University of Melbourne.

Dollár, Anna, & Steif, Paul S. (2012). Web-based statics course with learning dashboard for instructors. *Proceedings of computers and advanced technology in education (CATE 2012)*.

Dörner, Dietrich. (1996). The logic of failure: Why things go wrong and what we can do to make them right.

Draper, Stephen W, Cargill, Julie, & Cutts, Quintin. (2002). Electronically enhanced classroom interaction. *Australasian Journal of Educational Technology, 18*(1).

Engeström, Yrjö. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of education and work, 14*(1), 133-156.

Esnaashari, Shadi, Mathrani, Anuradha, & Watters, Paul. (2016). Investigation of Audience Interaction Tools from the Perspective of Activity Theory. *arXiv preprint arXiv:1606.01366*.

Fausett, LV, & Elwasif, W. (1994). *Predicting performance from test scores using backpropagation and counterpropagation.* Paper presented at the Neural Networks, 1994. IEEE World Congress on Computational Intelligence., 1994 IEEE International Conference on.

Feryok, Anne. (2012). Activity theory and language teacher agency. *The Modern Language Journal, 96*(1), 95-107.

Foot, Kirsten A. (2001). Cultural-historical activity theory as practice theory: illuminating the development of conflict-monitoring network. *Communication Theory, 11*(1), 56-83.

Fritz, John. (2010). Video Demo of UMBC's" Check My Activity" Tool for Students. *Educause Quarterly, 33*(4), n4.

Fuentes-FernÁNdez, Rubén, GÓMez-Sanz, Jorge J, & PavÓN, Juan. (2007). Managing contradictions in multi-agent systems. *IEICE transactions on information and systems, 90*(8), 1243-1250.

Fulford, Catherine P, & Zhang, Shuqiang. (1993). Perceptions of interaction: The critical predictor in distance education. *American Journal of Distance Education, 7*(3), 8-21.

Gardner, John W. (1995). *Self-renewal: The individual and the innovative society*: WW Norton & Company.

Gašević, Dragan, Dawson, Shane, & Siemens, George. (2015). Let's not forget: Learning analytics are about learning. *TechTrends, 59*(1), 64-71.

Georg, Geri, & France, RB. (2013). An Activity Theory Language: USE Implementation. *Colorado State University Computer Science Department Techn. Report, CS-13-101, http://www.cs.colostate. edu/TechReports/Reports/2013/tr13-101. pdf (acc*.

Georg, Geri, Mussbacher, Gunter, Amyot, Daniel, Petriu, Dorina, Troup, Lucy, Lozano-Fuentes, Saul, & France, Robert. (2015). Synergy between Activity Theory and goal/scenario modeling for requirements elicitation, analysis, and evolution. *Information and Software Technology, 59*, 109-135.

Goldstein, Philip J, & Katz, Richard N. (2005). Academic analytics: The uses of management information and technology in higher education.

Govaerts, Sten, Verbert, Katrien, Duval, Erik, & Pardo, Abelardo. (2012). *The student activity meter for awareness and self-reflection.* Paper presented at the CHI'12 Extended Abstracts on Human Factors in Computing Systems.

Grudnitski, Gary. (1997). A forecast of achievement from student profile data. *Journal of Accounting Education, 15*(4), 549-558.

Hämäläinen, Wilhelmiina, & Vinni, Mikko. (2006). *Comparison of machine learning methods for intelligent tutoring systems.* Paper presented at the Intelligent Tutoring Systems.

Hartigan, John A, & Wong, Manchek A. (1979). Algorithm AS 136: A k-means clustering algorithm. *Journal of the Royal Statistical Society. Series C (Applied Statistics), 28*(1), 100-108.

Hasan, Helen. (1999). Integrating IS and HCI using activity theory as a philosophical and theoretical basis. *Australasian Journal of Information Systems, 6*(2).

Hattie, John, & Timperley, Helen. (2007). The power of feedback. *Review of educational research, 77*(1), 81-112.

Hecking, Tobias, Ziebarth, Sabrina, & Hoop, HU. (2014). Analysis of Dynamic Resource Access Patterns in Online Courses. *Journal of Learning Analytics, JLA, 1*, 34-60.

Kabra, RR, & Bichkar, RS. (2011). Performance prediction of engineering students using decision trees. *International Journal of Computer Applications, 36*(11).

Kearsley, Greg. (1995). The nature and value of interaction in distance learning: ACSDE Research Monograph.

Kober, Nancy. (2015). *Reaching Students:: What Research Says About Effective Instruction in Undergraduate Science and Engineering*: National Academies Press.

Kotsiantis, Sotiris B, & Pintelas, Panayiotis E. (2005). *Predicting students marks in hellenic open university.* Paper presented at the Advanced Learning Technologies, 2005. ICALT 2005. Fifth IEEE International Conference on.

Kumari, D Siva. (2001). *Connecting graduate students to virtual guests through asynchronous discussions: analysis of an experience.* Paper presented at the Journal of Asynchronous Learning Networks.

Lantolf, James P, & Appel, Gabriela. (1994). *Vygotskian approaches to second language research*: Greenwood Publishing Group.

Lantolf, James P, Thorne, Steven L, & Poehner, Matthew E. (2000). Sociocultural theory and second language development.

Leonard, William H, & Chandler, Patricia M. (2003). Where is the inquiry in biology textbooks? *The American Biology Teacher, 65*(7), 485-487.

Leont'ev, Aleksei N. (1974). The problem of activity in psychology. *Soviet psychology, 13*(2), 4-33.

Littauer, Raphael. (1972). Instructional Implications of a Low-Cost Electronic Student Response System. *Educational Technology: Teacher and Technology Supplement, 12*(10), 69-71.

Lykourentzou, Ioanna, Giannoukos, Ioannis, Mpardis, George, Nikolopoulos, Vassilis, & Loumos, Vassili. (2009). Early and dynamic student achievement prediction in e-learning courses using neural networks. *Journal of the American Society for Information Science and Technology, 60*(2), 372-380.

Mazza, Riccardo, & Milani, Christian. (2004). *Gismo: a graphical interactive student monitoring tool for course management systems.* Paper presented at the International Conference on Technology Enhanced Learning, Milan.

McConnell, Jeffrey J. (1996). Active learning and its use in computer science. *ACM SIGCSE Bulletin, 28*(SI), 52-54.

McKeachie, Wilbert J. (1990). Research on college teaching: The historical background. *Journal of educational psychology, 82*(2), 189.

Meece, Judith L. (2001). *Child and Adolescent Development for Educators with Free Making the Grade*: McGraw-Hill Humanities, Social Sciences & World Languages.

Mills, Geoffrey E. (2000). *Action research: A guide for the teacher researcher*: ERIC.

Minaei-Bidgoli, Behrouz, & Punch, William F. (2003). *Using genetic algorithms for data mining optimization in an educational web-based system.* Paper presented at the Genetic and Evolutionary Computation—GECCO 2003.

Mostow, Jack, Beck, Joseph, Cen, Hao, Cuneo, Andrew, Gouvea, Evandro, & Heiner, Cecily. (2005). *An educational data mining tool to browse tutor-student interactions: Time will tell.* Paper presented at the Proceedings of the Workshop on Educational Data Mining, National Conference on Artificial Intelligence.

Murphy, Elizabeth, & Manzanares, María A Rodríguez. (2008). Contradictions between the virtual and physical high school classroom: A third-generation Activity Theory perspective. *British Journal of Educational Technology, 39*(6), 1061-1072.

Murphy, Elizabeth, & Rodriguez-Manzanares, Maria A. (2008). Using activity theory and its principle of contradictions to guide research in educational technology. *Australasian Journal of Educational Technology, 24*(4).

Ngai, Eric WT, Xiu, Li, & Chau, Dorothy CK. (2009). Application of data mining techniques in customer relationship management: A literature review and classification. *Expert systems with applications, 36*(2), 2592-2602.

Paris, Scott G, & Oka, Evelyn R. (1986). Children's reading strategies, metacognition, and motivation. *Developmental Review, 6*(1), 25-56.

Park, & Farag. (2015). Transforming the Legal Studies Classroom: Clickers and Engagement. *Journal of Legal Studies Education, 32*.

Pinninghoff Junemann, María, Salcedo Lagos, Pedro, & Contreras Arriagada, Ricardo. (2007). Neural Networks to Predict Schooling Failure/Success. *Nature Inspired Problem-Solving Methods in Knowledge Engineering*, 571-579.

Pintrich, Paul R. (1988). A process-oriented view of student motivation and cognition. *New directions for institutional research, 1988*(57), 65-79.

Pintrich, Paul R. (2000). An achievement goal theory perspective on issues in motivation terminology, theory, and research. *Contemporary educational psychology, 25*(1), 92-104.

Pintrich, Paul R, & De Groot, Elisabeth V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of educational psychology, 82*(1), 33.

Pistilli, Matthew D, & Arnold, Kimberly E. (2010). In practice: Purdue Signals: Mining real-time academic data to enhance student success. *About Campus, 15*(3), 22-24.

Pokay, Patricia, & Blumenfeld, Phyllis C. (1990). Predicting achievement early and late in the semester: The role of motivation and use of learning strategies. *Journal of educational psychology, 82*(1), 41.

Preszler, Ralph W, Dawe, Angus, Shuster, Charles B, & Shuster, Michèle. (2007). Assessment of the effects of student response systems on student learning and attitudes over a broad range of biology courses. *CBE-Life Sciences Education, 6*(1), 29-41.

Proceedings of the 1st International Conference on Learning Analytics and Knowledge. (2011). Banff, Alberta, Canada.

Ransdell, Sarah. (2001). Predicting college success: The importance of ability and non-cognitive variables. *International journal of educational Research, 35*(4), 357-364.

Rapoport, Robert N. (1970). Three dilemmas in action research with special reference to the Tavistock experience. *Human relations, 23*(6), 499-513.

Ravishankar, J, Epps, J, Ladouceur, F, Eaton, R, & Ambikairajah, E. (2014a). *Using iPads/Tablets as a teaching tool: Strategies for an electrical engineering classroom.* Paper presented at the Teaching, Assessment and Learning (TALE), 2014 International Conference on.

Ravishankar, J, Epps, J, Ladouceur, F, Eaton, R, & Ambikairajah, E. (2014b). *Using iPads/Tablets as a teaching tool: Strategies for an electrical engineering classroom.* Paper presented at the International Conference on Teaching, Assessment and Learning (TALE).

Romero, Cristóbal, Ventura, Sebastián, Espejo, Pedro G, & Hervás, César. (2008). *Data mining algorithms to classify students.* Paper presented at the Educational Data Mining 2008.

Santos, Jose Luis, Govaerts, Sten, Verbert, Katrien, & Duval, Erik. (2012). *Goal-oriented visualizations of activity tracking: a case study with engineering students.* Paper presented at the Proceedings of the 2nd international conference on learning analytics and knowledge.

Santos, Jose Luis, Verbert, Katrien, Govaerts, Sten, & Duval, Erik. (2013). *Addressing learner issues with StepUp!: an Evaluation.* Paper presented at the Proceedings of the Third International Conference on Learning Analytics and Knowledge.

Saroyan, Alenoush, & Snell, Linda S. (1997). Variations in lecturing styles. *Higher Education, 33*(1), 85-104.

Sheel, Stephen J, Vrooman, Deborah, Renner, René S, & Dawsey, Shanda K. (2001). A comparison of neural networks and classical discriminant analysis in predicting students' mathematics placement examination scores *Computational Science-ICCS 2001* (pp. 952-957): Springer.

Sibley, Jim, & Spiridonoff, Sophie. (2010). What is TBL? *Retrieved February, 23*, 2011.

Singer, Susan, & Smith, Karl A. (2013). Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering. *Journal of Engineering Education, 102*(4), 468-471.

Stanley, Julian C, & Hopkins, Kenneth D. (1972). *Educational and psychological measurement and evaluation*: Prentice Hall.

Steinert, Yvonne, & Snell, Linda S. (1999). Interactive lecturing: strategies for increasing participation in large group presentations. *Medical Teacher, 21*(1), 37-42.

Stubbs, Michael, Bernstein, Basil, & Labor, William. (1976). *Language, schools and classrooms*: Methuen London.

Talavera, Luis, & Gaudioso, Elena. (2004). *Mining student data to characterize similar behavior groups in unstructured collaboration spaces.* Paper presented at the Workshop on artificial intelligence in CSCL. 16th European conference on artificial intelligence.

Ting, SMR, & Man, R. (2001). Predicting academic success of first-year engineering students from standardized test scores and psychosocial variables. *International Journal of Engineering Education, 17*(1), 75-80.

Valsiner, Jaan. (2007). Culture in minds and societies: Foundations of cultural psychology. *Psychol. Stud.(September 2009), 54*, 238-239.

Van Lier, Leo. (2002). An ecological-semiotic perspective on language and linguistics. *Language acquisition and language socialization: Ecological perspectives*, 140-164.

Verbert, Katrien, Duval, Erik, Klerkx, Joris, Govaerts, Sten, & Santos, José Luis. (2013). Learning analytics dashboard applications. *American Behavioral Scientist*, 0002764213479363.

Verbert, Katrien, Govaerts, Sten, Duval, Erik, Santos, Jose Luis, Van Assche, Frans, Parra, Gonzalo, & Klerkx, Joris. (2014). Learning dashboards: an overview and future research opportunities. *Personal and Ubiquitous Computing, 18*(6), 1499-1514.

Vygotsky, Lev Semenovich. (1980). *Mind in society: The development of higher psychological processes*: Harvard university press.

Waldrop, M Mitchell. (2015). The Science of Teaching Science. London, England: Nature Publishing Group Macmillan

Wang, & Hannafin. (2005). Design-based research and technology-enhanced learning environments. *Educational technology research and development, 53*(4), 5-23.

Wang, & Newlin, Michael H. (2002). Predictors of performance in the virtual classroom: Identifying and helping at-risk cyber-students. *THE Journal (Technological Horizons In Education), 29*(10), 21.

Wang, Newlin, Michael H, & Tucker, Travis L. (2001). A discourse analysis of online classroom chats: Predictors of cyber-student performance. *Teaching of Psychology, 28*(3), 222-226.

Weaver, Robert R, & Qi, Jiang. (2005). Classroom organization and participation: College students' perceptions. *The Journal of Higher Education, 76*(5), 570-601.

Wieman, Carl E. (2014). Large-scale comparison of science teaching methods sends clear message. *Proceedings of the National Academy of Sciences, 111*(23), 8319-8320.

Winne, Philip H. (2006). How software technologies can improve research on learning and bolster school reform. *Educational Psychologist, 41*(1), 5-17.

Zaïane, Osmar R, & Luo, J. (2001). *Web usage mining for a better web-based learning environment.* Paper presented at the Proceedings of conference on advanced technology for education.

Zhu, Erping. (2007). Teaching with clickers. *Center for research on learning and teaching occasional papers, 22*, 1-8.

Zimmerman, Barry J. (2002). Becoming a self-regulated learner: An overview. *Theory into practice, 41*(2), 64-70.

Zimmerman, Barry J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Educational Research Journal, 45*(1), 166-183.

Zimmerman, Barry J, & Martinez-Pons, Manuel. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of educational psychology, 80*(3), 284.

Zimmermann, Barry J. (2001). *Theories of self-regulated learning and academic achievement: an overview and analysis. self-regulated learning and academic achievement: theoretical perspectives*: Zimmermann BJ ve Schunk, DH (edt). Mahwah, NJ, ABD.

Chapter 5

5.1 Discussion

In the literature, the importance of participation has been emphasized through different learning theories (Lave and Wenger, 1991;(Engeström, 2001; Leont'ev, 1974). Data in our study suggest that there was a lack of participation in the classes we observed.

Lack of participation can have different reasons such as cultural differences, peer pressure, anxiety, and risk avoidance (Weaver & Qi, 2005). In addition, some students did not feel like participating in the activities since they were afraid other students in the class would understand they did not know the answer to the questions.

For the reason of removing the fear of students from exposing their identity and knowledge to their class we introduced audience participation tools to the students. In so doing, the students were able to communicate anonymously with other students and with their lecturers in class. The students did not fear that by answering questions their knowledge will be known to others in class since the students' answer will be shown as aliases on the board. By doing so, we aimed to increase the anonymous participation in class.

We used the audience participation tool in different courses with different teaching styles to see the differences in the participation pattern of students in different classes. Our aim was to identify the different effects of using audience participation tool in different courses from different departments.

We were looking to understand students' perception regarding using the tool in their classes. For example, we wanted to know whether they felt using the tool in class would help them to participate more in class activities and whether this increase in participation would help them to engage and learn better in their classes. We not only wanted to understand students' perception regarding using the tool, but we also wanted to see the result of increasing participation in the course outcome.

In the first study presented in Chapter 2, the aim was to understand students' perception regarding using the tool in two Information Technology classes. The tool has been used for the second half of the course. We gave a low risk notification to the human ethics committee. Due to not having full ethics approval in the first study we could not look at

students' final course outcome. At the end of the class we ran a questionnaire. The lecturers in these two classes used two different teaching methods of traditional teaching in one class and activity based in the other class. We compared using the tool in two different classes with two different teaching methodologies. In the first study, we made our discussion based on activity theory which has a strong focus on participation. Activity theory mentioned that students need to participate in activities in the class in order to learn. It mentions participation is equal to learning. We used the tool to increase the anonymous participation in the class. Applying the elements of the activity theory as discussed by Engeström (2001) to our classroom settings, we found that audience participation tool has a promising direction for engaging students in the process of teaching and learning. However, engagement in the form of assessment is found to be higher, while engagement in the form of informal discussions may have less student participation but is considered more enjoyable. The data collected through our tool showed that the class which adopted an activity-oriented approach rendered better results as far as enjoyment of students is concerned while traditional classes showed higher engagement. The tool has proved to be effective in providing new insights to lecturers, students, and the institutions, and has potential to help all the parties involved so that the right decisions are made regarding the efficacy of the teaching and learning and the evaluation process. However, there were a few limitations in this study. For example, the study has been conducted in the second half of the teaching semester. It would have been better if we could have run the test from the beginning of the course to the end and put students under focus from the start to understand how their level of engagement changed during the course. Also, the low attendance and low response to the final survey tool were other limitations of this study. Moreover, we did not have full ethics approval and we were not able to look at students' final course outcome.

Therefore, for our Study 2 which has been presented in Chapter 3 and Chapter 4, we applied for a full human ethics approval from Massey University Human Ethics committee. After getting the approval, we ran the tool in two Marketing courses in a New Zealand university. This time we had permission to look at students' course outcome. We ran the tool for the whole semester for 12 weeks. In one class, the teacher used the tool for more discussion questions and in the other one the lecturer used the tool at the beginning of each session to

ask about the material the lecturer thought in the previous session. We collected participation data from these two classes through the audience participation tool. At the end of the class we ran the questionnaire to understand their perception regarding using the tool in the class. Self-report measures indicated that students enjoyed a more participatory approach to in-class teaching and learning. High percentages of the students in our study believed that the tool helped them to participate and engaged them more in class and consequently helped them in the process of learning. This is consistent with a number of theories relating to student motivation.

Our aim was not only to understand the perception of students regarding using the tool but also to learn if the final course outcome of the students proved the importance of participation in their classes. We tried to map students' questionnaire data with course outcome in Chapter 4. For this reason, we used an unsupervised clustering algorithm in order to cluster the students based on their participation in group activities in class. In clustering, the classes were not predefined at the stage of learning. The learning stage was used to determine the classes in the data sets. The data showed that students who participated more and thought that the tool helped them to learn, engaged and increased their interest in the course more, and eventually achieved the highest scores. This finding supports the view that in-class participation is critical to learning and academic success.

To put everything in a nutshell, we compared the joy of the students when the tool was used in different classes with different teaching styles. Data shows with using the tool in the class we increased the participation and course outcome. The tool itself proved to be effective in providing new insights to lecturers, students, and the institution, and had potential to help all parties involved so that the right decisions were made regarding the efficacy of the teaching and learning, and the evaluation process. Students showed interest in using the tool in their classes. They gave us very interesting feedback regarding using the tool in the classes. Students mentioned that the tool helped to learn and get engaged in the class.

Now that we saw the effect of increasing participation on the course outcome of the students, let us consider how we could increase the participation of students through other methods. It is good to investigate other methods and tools for increasing the participation

of students and see how it affects the course outcome. Then we can understand which methods is more helpful in increasing the participation and which methods of increasing participation have better effects on the course outcome?

We applied unsupervised learning algorithm, K-Means clustering algorithm. It is also needed to apply other methods of clustering and prediction to see if the attribute of participation is a good one for prediction.

We used the tool in IT, Marketing, and Construction in a New Zealand university. It is good to rerun the experiments in other universities and polytechnics in other different courses to see if they show the same results or if we can see the same pattern

5.2 Future work

Now that we saw the effect of participation on the course outcome of the students, time is to see how we could increase the participation of the students. It is good to investigate other methods and tools for increasing the participation of the students and see how it effects on the course outcome.

It is also need to apply other methods of prediction to see if the attribute of participation is a good one for prediction

We used the tool in IT, Marketing, and Construction in a New Zealand university. It is good to re run the experiments in other universities and polytechnics in different courses to see if they show the same results or can we see the same pattern.

Also, further investigation in the learning process of the students is needed to see how different tools can affect differently in self-regulating the learning of the students and consequently other final course outcome.

Appendix 1

Students’ survey questionnaire

Survey Instrument	
1	Did you attend all lectures? • Yes, I attended all the lectures. • I attended majority of the lectures. • I attended a few of the lectures. • No, I could not attend any of the lectures.
2.	What was your general impression regarding asking of questions during the class using Xorro-Q? • I enjoyed it. • It was OK • I have no opinion as such. • It was a waste of time.
3	How easy was it to use the software tool “Xorro-Q”? • Very easy • I worked it out • Not intuitive • Very hard
4	Do you think that by using the technique of asking questions through Xorro-Q, we can help you in the process of learning? • A lot • Somewhat • A little • Not at all
5	Do you think that by asking questions (with Xorro-Q), could highlight the gaps in your knowledge? • A lot • Somewhat • A little • Not at all

6	Do you think that by asking questions (with Xorro-Q), we can increase your interest in the course? • A lot • Somewhat • A little • Not at all
7	Do you think answering questions (using Xorro-Q) made you more attentive and remain engaged in class? • A lot • Some what • A little • Not at all
8	Did it help you to learn when you compared your result with other students' result when it was shown on the board? • A lot • Somewhat • A little • Not at all
9	How does it feel to see your answers displayed for everyone to see them? (Select as many as apply) • I enjoy it • It motivates me • It makes me more attentive • I find it scary
10	How would you like to see yourself displayed on the board? • By name • By ID • Anonymous • I do not care, either way

11	Do you think that by answering questions through Xorro-Q, it may have helped you in preparation for the exam? • Yes • No • I don't know
12	How do you like to study for the exam individually or in a group? • Prefer individual study • Prefer group study
13	What sort of mobile device did you use to connect to Xorro website?
14	What did you like about the tool (Xorro-Q) that we used in the class?
15	What did you NOT like about the tool (Xorro-Q) that we used in the class?
16	Can you suggest any improvements to the tool (Xorro-Q) we used in the class?
17	What would you have liked to be done differently in the class to engage you more?

Appendix 2

HEC application forms

Human Ethics Application

FOR APPROVAL OF PROPOSED RESEARCH/TEACHING/EVALUATION INVOLVING HUMAN PARTICIPANTS

(All applications are to be typed and presented using language that is free from jargon and comprehensible to lay people)

SECTION A

1 **Project Title** Bridging Learning Analytics with Xorro-Q Tool: An Institutional Dashboard Strategy

Projected start date for data collection 1/1/2016 **Projected end date** 1/6/2017

(In no case will approval be given if recruitment and/or data collection has already begun).

2 **Applicant Details** ***(Select the appropriate box and complete details)***

ACADEMIC STAFF APPLICATION (excluding staff who are also students)

Full Name of Staff Applicant/s

School/Department/Institute

Campus ***(mark one only)*** **Albany** ☐ **Palmerston North** ☐ **Wellington** ☐

Telephone **Email Address**

STUDENT APPLICATION

Full Name of Student Applicant	**Shadi Esnaashari**		
Employer (if applicable)			
Telephone	***0226719896***	**Email Address**	**S.esnaashari@massey.ac.nz**
Postal Address	**Building 106, Oteha Rohe Campus, Massey University**		
Full Name of Supervisor(s)	**Dr. Anuradha Mathrani (main supervisor), Prof. Paul Watters (Co-supervisor)**		
School/Department/Institute	**School of Engineering and Advanced Technology**		
Campus *(mark one only)*	**Albany** [X] **Palmerston North** [ ] **Wellington** [ ]		
Telephone		**Email Address**	A.S.Mathrani@massey.ac.nz (Main supervisor), P.A.Watters@massey.ac.nz(Co-supervisor)

GENERAL STAFF APPLICATION

Full Name of Applicant			
Section			
Campus *(mark one only)*	**Albany** [ ] **Palmerston North** [ ] **Wellington** [ ]		
Telephone		**Email Address**	
Full Name of Line Manager			
Section			
Telephone		**Email Address**	

3 Type of Project *(provide detail as appropriate)*

Staff Research/Evaluation:		Student Research:		If other, please specify:
Academic Staff		Specify Qualification	PhD in Information Technology	
General Staff		Specify Credit Value of Research	360	
Evaluation		(e.g. 30, 60, 90, 120, 240, 360)		

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4 Summary of Project

Please outline in no more than 200 words in lay language why you have chosen this project, what you intend to do and the methods you will use.

(Note: All the information provided in the application is potentially available if a request is made under the Official Information Act. In the event that a request is made, the University, in the first instance, would endeavour to satisfy that request by providing this summary. Please ensure that the language used is comprehensible to all.)

This study aims to increase engagement of students in university classes and identify the relationship between students' engagement and their course outcome. The study examines students' perceptions in regards to using technologies in classes, investigates whether students' participation improves by using audience interaction tools such as Xorro-Q and to what extent, identifies techniques to extend synchronous participation in classrooms and improves the overall teaching and learning experience.

In this study I will use Xorro-Q product in classes for which Massey University already has a license. This research is funded by Callaghan innovation for three years. In this partnership project between Two Touch Technologies (a New Zealand company) and Massey University, I will design a dashboard using an audience interaction tool, namely Xorro-Q, from Two Touch Technologies . Xorro-Q is a web-based audience response solution which can be used for live voting, data collection, brainstorming, instant formative assessment, and motivational learning games. Xorro tool anonymously saves data regarding students' attendance, scores in activities, and I plan to use the data recorded through Xorro tool. I will also interview a number of students (12 students)and teachers (6 teachers)to gain understanding regarding their use of audience interaction tools which will help in further enhancement of the current Xorro-Q tool and also help students, teachers

and institutions address concerns arising from high drop-out rate in classes across universities in New Zealand.

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5 **List the Attachments to your Application, e.g. Completed "Screening Questionnaire to Determine the Approval Procedure" (compulsory), Information Sheet/s *(indicate how many)*, Translated copies of Information Sheet/s, Consent Form/s *(indicate of how many),* Translated copies of Consent Form/s, Transcriber Confidentiality Agreement, Confidentiality Agreement *(for persons other than the researcher / participants who have access to project data)*, Authority for Release of Tape Transcripts, Advertisement, Health Checklist, Questionnaire, Interview Schedule, Evidence of Consultation, Letter requesting access to an institution, Letter requesting approval for use of database, Other *(please specify).***

I have attached all the documents namely Screening Questionnaire, Information Sheets, Consent Forms, Confidentiality Agreement, and Letter to Duncan O'Hara the director of national centre for teaching and learning and his reply to our request, Questionnaire, and Interview questions.

Applications that are incomplete or lacking the appropriate signatures will not be processed. This will mean delays for the project.

Please refer to the Human Ethics website (http://humanethics.massey.ac.nz) for details of where to submit your application and the number of copies required.

SECTION B: PROJECT INFORMATION

General

6	**I/We wish the protocol to be heard in a closed meeting (Part II).**	**Yes**		**No**	**X**
	(If yes, state the reason in a covering letter.)				
7	**Does this project have any links to previously submitted MUHEC or HDEC application(s)?**	**Yes**		**No**	**X**
	If yes, list the MUHEC or HDEC application number/s (if assigned) and relationship/s.				
8	**Is approval from other Ethics Committees being sought for the project?**	**Yes**		**No**	**X**
	If yes, list the other Ethics Committees. This study may be extended to other universities in New Zealand (eg. Unitec, AUT, UoA). However, if that is the case, ethics approval will be sought with the concerned institution's committee. All human ethics approvals will be disclosed to MUHEC as soon as they are received by the researcher.				
9	**For staff research, is the applicant the only researcher?**	**Yes**	**X**	**No**	
	If no, list the names and addresses of all members of the research team.				

Project Details

10 State concisely the aims of the project.

Following activity theory, this study examines students' participation in class activities. Lave and Wenger (1991) build on activity theory and state that participation improves learning. Drawing on sociocultural theories of learning, this study will utilize Xorro-Q tool to measure class participation of students in their class activities. It can be argued that audience participation tools could be used to increase engagement of students in class which could affect students' course outcome. This study is thus motivated to investigate the effect of using the tool on the course and the relationship between using the tool with the students' final course outcome. In this study the aim is to find out how early we can identify at risk students.

This project sits broadly in the domain of artificial intelligence and data science. The aim is to utilise machine learning algorithms in conjunction with student data in order to explore how early on in the course of study we can algorithmically identify at-risk students.

These kinds of systems are being deployed worldwide in a number of UK and US universities with positive outcomes for students. These systems can only be built with access to student data which is usually drawn from Moodle/Stream-based systems. Accuracy and overall effectiveness of these types of systems, and machine learning in general, can best be improved when augmented with more informative and descriptive data. Therefore, we seek to source data from an additional source (in-class participation data from Xorro_Q software) in order to determine if this type of data enables earlier detection of at-risk students than previously possible using more traditional data sources.

In addition, we then hope to more generally determine if audience participation software increases overall student participation in the course and how this affects their motivation and achievements in various assessments.

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11 Give a brief background to the project to place it in perspective and to allow the project's significance to be assessed. ***(No more than 200 words in lay language)***

In this study I seek to increase student participation and its effect on the course outcome. I will use Xorro-Q to collect longitudinal data from students regarding their participation rate and their result in tests. Also with student participation information from their activities through Stream. I will combine the data from Stream from before and after class participation with Xorro-Q's data from class participation to identify the relationship between student participation and course outcome.

Three research questions will be addressed:

How early we can identify at risk students?

Does students' participation improve by using audience participation tools such as Xorro-Q?

To what extent does synchronous participation in class influence study motivation, subject grades, and course completion?

In this study I plan to examine the student participation rate in the class and see the effect on their course outcomes. This will help in early prediction of student performance based on their participation in the classroom and student's historical data. This research is significantly important because with high level of confidence of prediction, this can help both students and the university. The university can get an idea advance about the probability of students pass rate based on historical data and the lecturer can assist the at risk students.

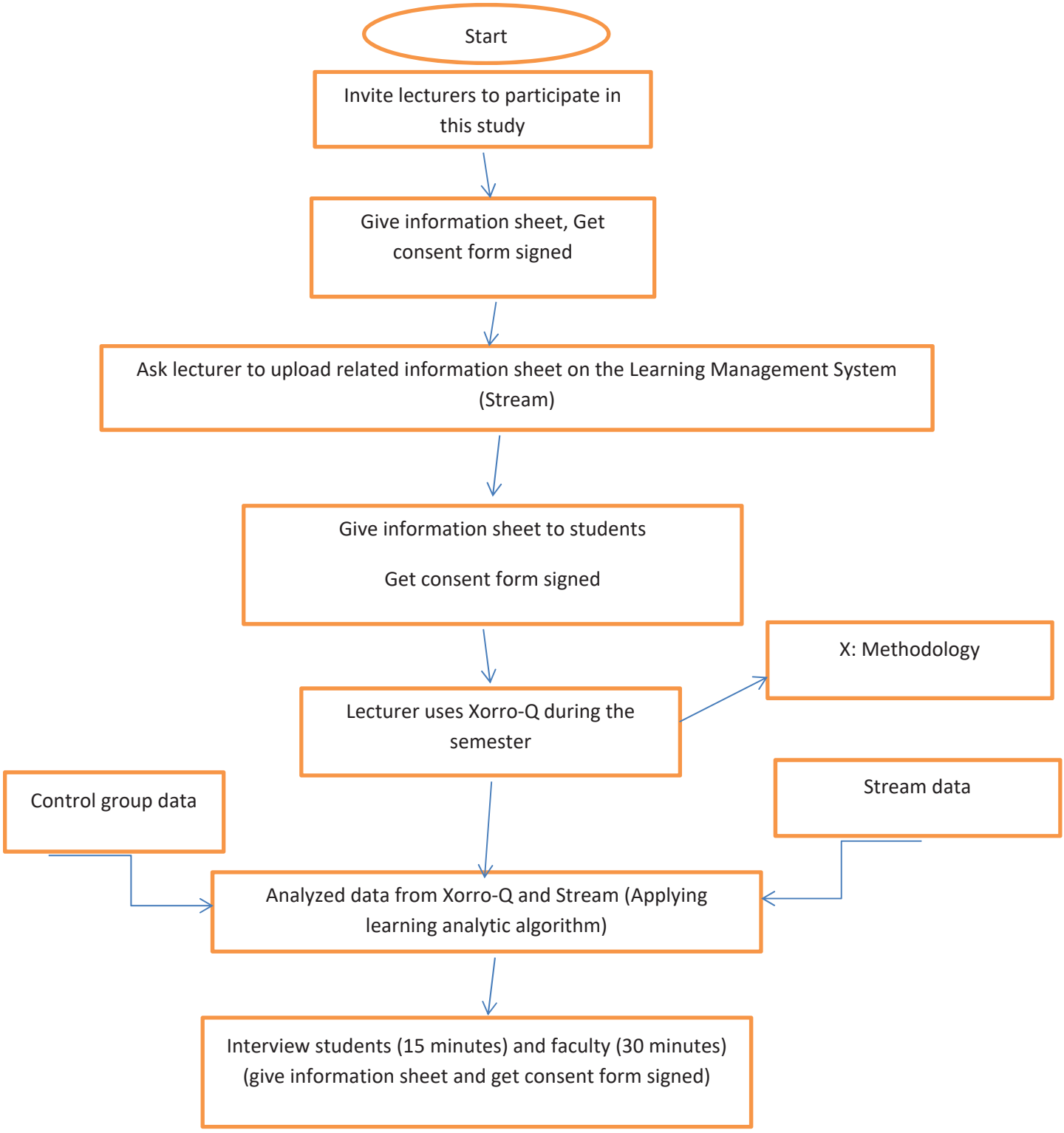
12 Outline the research procedures to be used, including approach/procedures for collecting data. Use a flow chart if necessary.

For data collection, I will send emails to lecturers and ask for their participation in this study. I will send an information sheet (Appendix A and G) to the lecturer explaining the aim of this project. If the lecturer agrees to participate in my study, Then I will give the consent form to the teacher to sign (Appendix E). They will be asked to upload the information sheet for the students (Appendix B) on the course website.

I will next visit their class and distribute the information sheet (Appendix B) to students informing them about this study. All students will be invited to participate. Further, all students will be assured that their data will be anonymized and this study will look at overall student performances. Written consent will be obtained from students who agree to participate (Appendix C). Students who do not sign the consent form will be eliminated from this study.

Next, at the end of the teaching semester, I would like to interview two students from each class and the lecturer of the class to understand their experiences using the tool. Therefore, I will go to the class again and request for their participation of students. Another consent form (Appendix D) will be given to students to sign if they agree to participate. Finally, I will conduct a 15 minute interview the first two students (who have signed the consent form) to gain some understanding on how they perceive use of real-time audience interaction tools in classrooms. Interviews will be held at Massey campus at a time suitable to the student. No questions of a personal nature will be asked.

The lecturer will be interviewed separately at their preferred time(30minutes). Lecturers too will be asked how they considered use of the Xorro-Q tool helped in their teaching with the tool.



Note: X: Methodology has been explained further.

X: Methodology

To address the questions data will be collected through three experiments:

The first two experiments would be in within subject design:

First experiment:

In the first experiment, the length of the teaching semester will be divided into two parts. In the first half, the teacher will not be using Xorro-Q, but in the second half the teacher will use Xorro-Q. At the end of each half, the teacher will be requested to conduct a test (Test A1 and Test A2) to evaluate the effects of using Xorro-Q on students' learning. This test will not be included in any of their formal assessments. Participation in the test by students is voluntary. In this experiment, the teacher, course and the students will remain the same but the tool will be added or removed at different times from the experiment. In this experiment the students themselves will act as a control group for themselves.

Teacher A, same students, same course	First 6 weeks Not using Xorro-Q	Test A1 (not included in the student's formative assessment)	Last 6weeks Using Xorro-Q	Test A2 (not included in the student's formative assessment)	Final Mark

Second experiment:

For my second experiment, I will re-run the experiment in another class. However, this time half the will be using Xorro-Q in the first half and not use it in the second half so that I have control the sequence effect. The teacher will be requested to conduct tests (Test B1 and Test B2) to evaluate the effects of using Xorro-Q on students' learning. In this experiment the students will act as a control group for themselves.

Teacher B, same students, same course	6 weeks using Xorro-Q	Test B1 (not included in the student's formative assessment)	6weeks Not Using Xorro-Q	Test B2 (not included in the student's formative assessment)	Final Marks

After running experiment 1 and experiment 2, we will compare the course outcome of two experiments 1 and 2 to find the best timing

For experiments 1 and 2, the tool will be used in half of the course (6 weeks) and not be used in the other half (6 weeks). Only in this way can meaningful comparisons be made in regard to the tool. The ultimate outcome of this practice to empower learners who are at risk. To do this I want to examine the efficacy of the tool on the learners. The best way to do this is to try the tool on the same students in the class. In this way the students are the control group for themselves. In half of the course the tool will be used with the students and in half of the course the tool will not be used with the same students. The effect of using the tool and not using it will be clarified by the assessment at the end of each half.

After finishing experiment 1 and experiment 2, we can apply learning analytics across their course outcomes to find the best time for using the tool.

Only in the 3rd experiment, the control group is an external group of students which will help in making generalizations about the effect of the tool. In experiment 3, I am going to examine the effects of using the tool in the full length of the semester. In this way the tool will not be used in 2016 for a specific course, but will be introduced in 2017 for the same course topic and the same teacher. Therefore, 2016 students would be the control group for this study. The outcome comparison of these two groups will clarify the effect of using the tool.

However, if the lecturer leaves the university or does not take the course in 2017, having more data across different universities and different topics will help to triangulate my data and reduce the impact of variations my results. Also analytical methods will be applied with consideration to change in the variable.

For all my experiments, there are no fixed sessions specified on student attendance. As and when students attend the class, they will use the tool in the class and data will be collected through Xorro-Q tool. There is no need to take student attendance, as student responses will automatically be collected through the tool thereby giving an indication about their attendance.

It is hoped that by collecting data from Xorro-Q and combine it with the data from stream, we could achieve a better prediction compare to the studies conducted in the literature.

I will interview only two students in each class (for experiment 1, experiment 2, and experiment 3 (only experimental group)). Each one will be interviewed only once. I will not ask students about their final grades, only about their perception on using the tool in the class.

In the interviews, no information other than their course outcomes will be obtained from the control group.

I am not going to get any information from the control group except their course outcome and the data from their assignments in the class(if there is any assignment conducted by the lecturer).

These experiments will also be run at the University of Auckland, Auckland University of Technology, and Unitec after the experiments have been run and analysed at Massey University. Again, human ethics approval will be obtained from these universities with the help of academics there. As and when ethics approval will be obtained from these institutions, I will make MUHEC aware of these approvals, before I conduct the study there.

13 **Where will the project be conducted? Include information about the physical location/setting.**

Massey University, Albany

14 **If the study is based overseas:**

i) Specify which countries are involved;

ii) Outline how overseas country requirements (if any) have been complied with;

iii) Have the University's Policy & Procedures for Course Related Student Travel Overseas been met?
(Note: Overseas travel undertaken by students – refer to item 5.10 in the document "Additional Information" on the MUHEC website.)

No.

15 **Describe the experience of the researcher and/or supervisor to undertake this type of project?**

I did my Master study in Victoria University of Wellington. My project used a mixed method, which involved both qualitative and quantitative study. I had full ethics approval from Victoria University of Wellington Ethics committee, and achieved an “A” for my 120 credit thesis. I believe I have a good knowledge of conducting study in using mix method and also maintaining the privacy of my human participants.

My supervisors have done much research using both quantitative and qualitative research with their PhD/Masters students, and have published many research papers that support student learning, through use of ICT to enhance teaching and learning pedagogies in journals and conferences (ranked A*, A, B). They have immense expertise in data science methods, such as applications of analytical and predictive algorithms to big datasets.

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16 Describe the process that has been used to discuss and analyse the ethical issues present in this project.

(A) I had initial discussions with supervisors and other stakeholders within the University about obtaining informed consent from participants, and also trying to identify potential harms or adverse consequences from undertaking the study in the format planned. I also undertook a risk assessment to determine the likelihood and impact of any adverse events, eg, the likelihood of reverse identification of anonymised participant records, and still felt that answering the research questions for the greater good, in my mind, outweighed the potential harms to individuals.

We needed to collect and analysed the students' personal data which could not be the interest of the users. We will give information sheet to the students before start to collecting their data for our study and sought for their consents. If they agree to participate, we use their data.

We make them sure that we will use high level of anonymity to maintain the privacy of the data.

We are analysing the learning path of the students but personal data which could expose the identity of the student will not be used. We asked the teacher to use the ID code for students to use in Xorro_Q. Also for the students' final score we will get the scores from the consent teacher by the students' ID codes.

When we interview the students the identity of the student will be clear for the interviewee, pseudonym will be used to maintain the privacy of the user. We will omit any student's information which could effects on reverse identifying of the student (For example if just one person got a specific score, this could help to identify the student, so this information will be deleted).

We also know that students are very stressful about their grades, therefore we are not asking anything from students regarding their grades in order to prevent giving stress to the students. Consulting with teaching policy this is something that we avoid. We just like to help the students and we want to see all the students successful. Therefore, we avoid anything that gives stress to the students and effect their performance.

We also omit the name of the teacher. No information will be exposed to the reader which could lead to identifying learners and their teachers.

We also will inform the Teaching and learning support, if the results of analysis shows that the tool was helpful so that they can recommend the tool to the lecturer so that other students and our control group was not disadvantaged from that.

(B) I submitted my research plan and gave a presentation to the NZ Information Systems Doctoral Consortium (NZISDC), attended by leading professors in my discipline from across NZ. They provided feedback to me on issues surrounding experimental design and ethics. (C) I reviewed numerous papers in this field, all of which have been approved by ethics committees, and my design reflects this analysis.

Participants

17 Describe the intended participants.

Students and staff members from Massey University will be the participants for this study.

18 How many participants will be involved?

The study will investigate the quantitative data collection. Interviews will only serve to complement the quantitative data findings to give richer insights on student perception.

For interviews, we have 6 classes and I will interview 2 students in each of the classes. It would be 12 interview with the students and 6 interviews with the lecturers. In total I would have 18 interviews. Bertaux (1981) argued that 15 is smallest acceptable sample size in qualitative studies when using interviews .

For action research I will choose 6 lecturers and the number of participants depends on the number of students enrolled in the class. As Daniel (2012: p.243) mentioned that 3 to 5 participants are enough for action study research. This study will use 6 lecturers participants.

For my experiment, the number of participant depends on the number of students enrolled in each of these 6 classes. My study would be purposive sampling as I have a criteria for students to be involved in this study (Patton,2002). Students need to have internet enabled devices in order to participate in this study.

Based on other similar studies (Jakub,2015;Macfadyen,2010) they have around 112 to 140, We hope that we can recruit the same number of participants.

Frederick Mosteller (1995) with the review on 59 studies suggested the effect size of 0.25. With G power calculation the total sample size would be 164 students in between subject design. We hope that we can recruit the same number of participants; however, this depends on student enrolments. For within the subject design, they mentioned two groups of twenty students are enough. If I can have 20 students for experiment 1, 20 students for experiment 2, and 164 students for experiment 3 is enough to proof my hypothesis.

What is the reason for selecting this number?

(Where relevant, attach a copy of the Statistical Justification to the application form)

The number of students is dependent on the individual classes.

19 Describe how potential participants will be identified and recruited?

For data collection, I will send emails to lecturers and ask for their participation in this study. I will send an information sheet to the lecturer and explain the aim of the project. If the lecturer agrees to participate in this study, then I will go with the lecturer to the class to ask the students for their participation in the study.

Teachers may change during the teaching semester. This change will be incorporated to variables in learning analytics. Changes in teacher will be compared across different data sets to see if that impacts the outcomes, and add to my study insights.

I will recruit participant for all three experiment at the same time.

20	**Does the project involve recruitment through advertising?**	**Yes**		**No**	**X**
	(If yes, attach a copy of the advertisement to the application form)				
21	**Does the project require permission of an organisation (e.g. an educational institution, an academic unit of Massey University or a business) to access participants or information?**	**Yes**	**X**	**No**	

If yes: i) list the organisation(s)

ii) attach a copy of the draft request letter(s) to the application form, e.g. letter to Board of Trustees, PVC, HoD/I/S, CEO etc (include this in your list of attachments (Q5).

(Note that some educational institutions may require the researcher to submit a Police Security Clearance.)

I sent the letter to Duncan O'Hara, the director of national centre for teaching and learning. He has given me the permission for accessing the students' course outcome from Stream. He gave me the permission to ask the lecturer for the final grade of the students who agreed to participate in my research.

Since I aim to run the experiments in different universities and in different disciplines, after I get the HEC from Massey University, I will apply to get HEC from the University of Auckland, Auckland University of Technology, and Unitec.

22 Who will make the initial approach to potential participants?

The main researcher (Shadi Esnaashari) will make the initial approach to potential participants by going to their classes with the lecturer of the class.

Yes, first I will get the consent from the lecturer and then only will I approach the students.

23 Describe criteria (if used) to select participants from the pool of potential participants.

I will send email to the lecturers and will invite them to use Xorro-Q in their class. Once participants have been recruited, the tool will be run in selected classes and start to gather the data regarding student attendance, students' score, and how they interact in the classes. Xorro-Q is a simple tool to ask subject related questions in the class. Massey university has the license for using it and this tool has been used in some classes in Massey University in Science, Business, and Health departments. There would be random sampling in selecting students for interviews.

As it is mentioned in the above paragraph, there is no selection for participation of this study in terms of using the tool in the class. I will use the data from Xorro-Q and Stream from all students who agree to participate in the study. At the end of the class I want to conduct the interviews the students. All the students will be invited, but only the first two students who respond and agree to be interviewed will be interviewed.

24 How much time will participants have to give to the project?

The interviews will last for 15 min. No extra work will be required from the students.

Added to the schematic defined for question 12. Lecturer will be interviewed for 30 minutes.

I also request the lecturer to make two sets of questions for their period of teaching, this may require them to do extra activity.

Data Collection

25 Does the project include the use of participant questionnaire/s? **Yes** [X] **No** [ ]

(If yes, attach a copy of the Questionnaire/s to the application form and include this in your list of attachments (Q5))

If yes: i) indicate whether the participants will be anonymous (i.e. their identity unknown to the researcher). **Yes** [X] **No** [ ]

ii) describe how the questionnaire will be distributed and collected.

(If distributing electronically through Massey IT, attach a copy of the draft request letter to the Associate Director Service Delivery, Information Technology Services to the application form. Include this in your list of attachments (Q5) – refer to the policy on "Research Use of IT Infrastructure").

(Note: All requests for IT related aspects of ethics committee approvals can be directed through the IT service desk in the first instance – the request will be registered and on a response timeline, with the Associate Director dealing with the request).

(Appendix H is the student questionnaire)The questionnaire will be distributed through the Xorro-Q tool that the teacher has been used it during the class. The students will answer the questions and it will be saved on Amazon servers in Australia.

26	**Does the project involve observation of participants? If yes, please describe.**	**Yes**		**No**	**X**
27	**Does the project include the use of focus group/s?**	**Yes**		**No**	**X**

(If yes, attach a copy of the Confidentiality Agreement for the focus group to the application form)

If yes, describe the location of the focus group and time length, including whether it will be in work time. ***(If the latter, ensure the researcher asks permission for this from the employer).***

28	**Does the project include the use of participant interview/s?**	**Yes**	**X**	**No**	

(If yes, attach a copy of the Interview Questions/Schedule to the application form)

If yes, describe the location of the interview and time length, including whether it will be in work time. ***(If the latter, ensure the researcher asks permission for this from the employer)***

The interview will take place in the university premises anywhere that is more comfortable for the students and lecturers. The interview time would be anytime between 9:00 am and 5:00 pm again in student's convenience time.

29	**Does the project involve sound recording?**	**Yes**	**X**	**No**	
30	**Does the project involve image recording, e.g. photo or video?**	**Yes**		**No**	**X**

If yes, please describe. ***(If agreement for recording is optional for participation, ensure there is explicit consent on the Consent Form)***

31	**If recording is used, will the record be transcribed?**	**Yes**	**X**	**No**	

If yes, state who will do the transcribing.

(If not the researcher, a Transcriber's Confidentiality Agreement is required – attach a copy to the application form. Normally, transcripts of interviews should be provided to participants for editing, therefore an Authority For the Release of Tape Transcripts is required – attach a copy to the application form. However, if the researcher considers that the right of the participant to edit is inappropriate, a justification should be provided below.)

The main researcher (Shadi Esnaashari) will do transcribing. Transcribed notes will be kept in a locked drawer in Massey University.

32	**Does the project involve any other method of data collection not covered in Qs 25-31?**	**Yes**		**No**	**X**
	If yes, describe the method used.				
33	**Does the project require permission to access databases?**	**Yes**	**X**	**No**	

(If yes, attach a copy of the draft request letter/s to the application form. Include this in your list of attachments (Q5). Note: If you wish to access the Massey University student database, written permission from Director, National Student Relations should be attached.)

I will not be having access to the student database. I sent a letter to Duncan O'Hara, the Director National Centre for Teaching and Learning. He has given permission to access students' data through the lecturers.

I will prepare a list of the students who agreed to participate in my study and will give the list to the lecturer of the course so that the lecturer could give me the data for those particular students.

Students can choose to use the tool but not participate in the study. They can give me their names and I will not use their data from the Xorro-Q database and Stream.

34 **Who will carry out the data collection?**

The researcher will collect the data. Actually the quantitative data will be gathered through Xorro-Q, Stream, and quantitative data will be gathered through interviews which will be conducted by the researcher.

SECTION C: BENEFITS / RISK OF HARM (Refer Code Section 3, Para 10)

35 What are the possible benefits (if any) of the project to individual participants, groups, communities and institutions?

This study is expected to have contributions for students, tutors, lecturers, and academic institutions. Lecturers and tutors can reflect on their own teaching while using the tool in their classes. Also, students can have access to their participation patterns and could take the necessary measures from early on in the course. The institution can identify vulnerable students more easily and help them with their possible problems.

The study will give in-depth analysis using learning analytics on how to engage students more during classroom teaching sessions. This has implications for further development of innovative learning pedagogies, assessment models and design tools to support student-cantered learning.

36 What discomfort (physical, psychological, social), incapacity or other risk of harm are individual participants likely to experience as a result of participation?

The interviewees will not be asked any questions which have a personal nature. Personal questions can cause discomfort. I will not ask students about their grades or other course outcomes (which can cause them distress). The purpose of this study is to get student perspectives on audience interaction tools to offer insightful data to complement my findings from application of analytics. Hence only questions related to Xorro-Q tool usage will be asked.

37 Describe the strategies you will use to deal with any of the situations identified in Q36.

I have updated the information sheet.

I would like to invite some of you for an interview in regard to usage of this tool (Xorro-Q) in the classroom. Your participation is voluntary and you are in no way obliged to give an interview; however, I assure you no questions of a personal nature will be asked. I would like to know your views on using synchronous audience interaction tools during conduct of lectures. You can refuse to answer any question at any time of the interview. In case of any stress/ discomfort please let me know and I will stop the interview. Also please be aware Massey University Counselling Centre (Level 2, Student Central, Albany) offers free counselling service to students .

38 **What is the risk of harm (if any) of the project to the researcher?**

None

39 **Describe the strategies you will use to deal with any of the situations identified in Q38.**

N/A

40 **What discomfort (physical, psychological, social) incapacity or other risk of harm are groups/communities and institutions likely to experience as a result of this research?**

None

41 **Describe the strategies you will use to deal with any of the situations identified in Q40.**

N/A

42 **Is ethnicity data being collected as part of the project?** **Yes** [ ] **No** [X]

If yes, please describe how the data will be used.

(Note that harm can be done through an analysis based on insufficient sample or sub-set numbers).

43 **If participants are children/students in a pre-school/school/tertiary setting, describe the arrangements you will make for children/students who are present but not taking part in the research.**

N/A

(Note that no child/student should be disadvantaged through the research)

If student do not like to participate in this study they may not use the tool. However, they could still use the tool. If they have not signed the consent form, I will not use their data (from the server) for my study .

SECTION D: INFORMED & VOLUNTARY CONSENT (Refer Code Section 3, Para 11)

44 By whom and how, will information about the research be given to potential participants?

The researcher has prepared a consent form which will be posted to the Stream and course web site by the teacher. The researcher also will go with the teacher on the first day of class to give the information sheet and consent form to the students.

The students can choose to withdraw from the study anytime until the end of the data collection phases. If the students do not agree to take part in my study, they do not sign the consent form. Even if the student chooses to use the tool he/she is not yet required to participate in the study. Therefore, he/she can inform me and I will delete his data from my study.

Some staffs are already using Xorro-Q in their classes (licensed to Massey) and the students need internet enabled devices in order to participate in this study.

45	**Will consent to participate be given in writing?**	**Yes**	**X**	**No**	

(Attach copies of Consent Form/s to the application form)

If no, justify the use of oral consent.

Teachers and students consent form would be written. When we want to interview students the consent form would be written as well.

46	**Will participants include persons under the age of 16?**	**Yes**		**No**	**X**

If yes: i) indicate the age group and competency for giving consent.

	ii) indicate if the researcher will be obtaining the consent of parent(s)/caregiver(s).	**Yes**		**No**	**X**

(Note that parental/caregiver consent for school-based research may be required by the school even when children are competent. Ensure Information Sheets and Consent Forms are in a style and language appropriate for the age group.)

47	**Will participants include persons whose capacity to give informed consent may be compromised?**	**Yes**		**No**	**X**

If yes, describe the consent process you will use.

48	**Will the participants be proficient in English?**	**Yes**	**X**	**No**	

If no, all documentation for participants (Information Sheets/Consent Forms/Questionnaire etc) must be translated into the participants' first-language.

(Attach copies of the translated Information Sheet/Consent Form etc to the application form)

SECTION E: PRIVACY/CONFIDENTIALITY ISSUES (Refer Code Section 3, Para 12)

49	**Will any information be obtained from any source other than the participant?**	**Yes**	**X**	**No**	

If yes, describe how and from whom.

Some additional information such as course outcome, assignments score will be required; in that case the information will be acquired from consent teachers from the stream .

50	**Will any information that identifies participants be given to any person outside the research team?**	**Yes**		**No**	**X**

If yes, indicate why and how.

51	**Will the participants be anonymous (i.e. their identity unknown to the researcher?)**	**Yes**		**No**	**X**

If no, explain how confidentiality of the participants' identities will be maintained in the treatment and use of the data.

Students' identity in all the publication and thesis would be anonymized. When we are collecting the data from the students during their course of study in Massey university through Xorro-Q they are anonymous to the researcher but when the researcher want to do the interview, the identity of the students will not be anonymized for the researcher but the information would be anonymized.The pseudonym will be used to protect the privacy and identity of the participant in all the publication. For conducting the questionnaire, the Xorro-Q will be used. At the beginning I wanted to conduct the questionnaire through Google docs, but in this way, if the student changed his/her mind and wanted me to delete its data from the study I could not do that. I did not want to give the feeling to the student that they cannot change their mind about participating in this study. That's why I will use Xorro-Q for conducting the survey.

52	**Will an institution (e.g. school) to which participants belong be named or be able to be identified?**	**Yes**		**No**	**X**

If yes, explain how you have made the institution aware of this?

53 **Outline how and where:**

i) the data will be stored, and

The data will be stored on the server and papers from the information sheet and consent forms will be saved in a locked place.

(Pay particular attention to identifiable data, e.g. tapes, videos and images)

ii) Consent Forms will be stored.

In a lock drawer in Massey University.

(Note that Consent Forms should be stored separately from data)

54 **i) Who will have access to the data/Consent Forms?**

The researcher and her supervisors have access to the data.

ii) How will the data/Consent Forms be protected from unauthorised access?

We will lock them in a safe place in Massey University, Albany.

55 **How long will the data from the study be kept, who will be responsible for its safe keeping and eventual disposal? (Note that health information relating to an identifiable individual must be retained for at least 10 years, or in the case of a child, 10 years from the age of 16).**

The data from this study will be disposed 3 years after finishing the PhD to allow the researcher to publish papers using the data collected.

(For student research the Massey University HOD Institute/School/Section / Supervisor / or nominee should be responsible for the eventual disposal of data. Note that although destruction is the most common form of disposal, at times, transfer of data to an official archive may be appropriate. Refer to the Code, Section 4, Para 24.)

SECTION F: DECEPTION (Refer Code Section 3, Para 13)

56 **Is deception involved at any stage of the project?**	**Yes**		**No**	**X**

If yes, justify its use and describe the debriefing procedures.

SECTION G: CONFLICT OF ROLE/INTEREST (Refer Code Section 3, Para 14)

57	**Is the project to be funded or supported in any way, e.g. supply of products for testing?**	**Yes**	**X**	**No**	

If yes: i) state the source of funding or support:

Massey Academic Unit

Massey University (e.g. MURF, SIF)

External Organisation (provide name and detail of funding/support)

This project is funded by Callaghan innovation and Xorro-Q does not contribute financially to it. Callaghan innovation pays the scholarship monthly to the university scholarship office and the scholarship office pays that to my account. There is also a host fee for each year of my study which Callaghan pays to the Massey University.

ii) does the source of the funding present any conflict of interest with regard to the research topic?

No

iii) identify any potential conflict of interest due to the source of funding and explain how this will be managed?

N/A

58	**Does the researcher/s have a financial interest in the outcome of the project?**	**Yes**		**No**	**X**

If yes, explain how the conflict of interest situation will be dealt with.

59 **Describe any professional or other relationship between the researcher and the participants? (e.g. employer, employee, work colleague, lecturer/student, practitioner/patient, researcher/family member). Indicate how any resulting conflict of role will be dealt with.**

No professional or other relationships with participant.

SECTION H: COMPENSATION TO PARTICIPANTS (Refer Code Section 4, Para 23)

60	**Will any payments, koha or other form of compensation or acknowledgement be given to participants?**	**Yes**		**No**	**X**

If yes, describe what, how and why.

(Note that compensation (if provided) should be given to all participants and not constitute an inducement. Details of any compensation provided must be included in the Information Sheet.)

SECTION I: TREATY OF WAITANGI (Refer Code Section 2)

61	**Are Maori the primary focus of the project?**	**Yes**		**No**	**X**

If yes: Answer Q62 – 65

If no, outline: i) what Maori involvement there may be, and

ii) how this will be managed.

I do not any knowledge about students' ethnicity and in data collection no information will be collected concerning students' cultural details.

This project does not involve any predetermined ethnic or social group. In other words, it only considers the effect of the tool in undergraduate courses irrespective of their social or ethnic identities.

They may some Maori students in the class. After consulting with Dr Ali Ajmol, we communicate with Kawharu to get advice from her.

62	**Is the researcher competent in te reo Maori and tikanga Maori?**	**Yes**		**No**	**X**

If no, outline the processes in place for the provision of cultural advice.

I do not have any knowledge about students' ethnicity and in data collection no data will be collected about the students' cultural data.

This project does not involve any predetermined ethnic or social group. In other words, it only considers the effect of the tool in undergraduate courses irrespective of their social or ethnic identities.

63 **Identify the group/s with whom consultation has taken place or is planned and describe the consultation process.**

(Where consultation has already taken place, attach a copy of the supporting documentation to the application form, e.g. a letter from an iwi authority)

N/A

64 **Describe any ongoing involvement of the group/s consulted in the project.**

N/A

65 **Describe how information resulting from the project will be shared with the group/s consulted?**

The aim would be to publish papers in high ranked conferences and journal papers to inform other researchers about the results of increasing interaction between students and lecturers. Also about the effect of using different pedagogies in the student learning process. The effect of increasing engagement and choice of pedagogy in the course outcome of the students will also be displayed through dashboards once appropriate learning algorithm and data mining strategies are applied.

SECTION J: CULTURAL ISSUES (Refer Code Section 3, Para 15)

66 What ethnic or social group/s (other than Maori) does the project involve?

This project does not involve any predetermined ethnic or social group. In other words, it only considers the effect of the tool in undergraduate courses irrespective of their social or ethnic identities.

We anticipated having students from all the cultures and after talking to Dr Ajmol Ali, we are in the process of getting advice from Margaret Kawharu.

67	**Are there any aspects of the project that might raise specific cultural issues?**	**Yes**		**No**	**X**

If yes, explain. Otherwise, proceed to Section K.

68	**Does the researcher speak the language of the target population?**	**Yes**	**X**	**No**	

If no, specify how communication with participants will be managed.

.

69 Describe the cultural competence of the researcher for carrying out the project.

(Note that where the researcher is not a member of the cultural group being researched, a cultural advisor may be necessary)

70 Identify the group/s with whom consultation has taken place or is planned.

(Where consultation has already taken place, attach copy of the supporting documentation to the application form)

71 Describe any ongoing involvement of the group/s consulted in the project.

.

72 Describe how information resulting from the project will be shared with the group/s consulted.

73 If the research is to be conducted overseas, describe the arrangements you will make for local participants to express concerns regarding the research.

.

SECTION K: SHARING RESEARCH FINDINGS (Refer Code Section 4, Para 26)

74 Describe how information resulting from the project will be shared with participants and disseminated in other forums, e.g. peer review, publications, and conferences.

(Note that receipt of a summary is one of the participant rights)

The summary of findings will be emailed to the participant. The participant also can access the thesis and any publication we had produced from the project.

SECTION L: INVASIVE PROCEDURES/PHYSIOLOGICAL TESTS (Refer Code Section 4, Para 21)

75	**Does the project involve the collection of tissue, blood, other body fluids; physiological tests or the use of hazardous substances, procedures or equipment?**	**Yes**		**No**	**X**

If yes, are the procedures to be used governed by Standard Operating Procedure(s)? If so, please name the SOP(s). If not, identify the procedure(s) and describe how you will minimise the risks associated with the procedure(s)?

76	**Does the project involve the use of radiation (x-ray, CT scan or bone densitometry (DEXA))?**	**Yes**		**No**	**X**
	If yes, has the Massey Licensee been contacted and consulted?	**Yes**		**No**	

(A copy of the supporting documentation must be provided with the ethics application, i.e. relevant SOP, participant dose assessment calculation sheet and approval of the dose assessment from the relevant authority). NOTE: See "Additional Information for Researchers" (Item 4.2) document for further detail.

(If yes to Q75 and/or Q76, complete Section L; otherwise proceed to Section M)

77 **Describe the material to be taken and the method used to obtain it. Include information about the training of those taking the samples and the safety of all persons involved. If blood is taken, specify the volume and number of collections.**

N/A

78	**Will the material be stored?**	**Yes**		**No**	**X**

If yes, describe how, where and for how long.

79 **Describe how the material will be disposed of (either after the research is completed or at the end of the storage period).**

(Note that the wishes of relevant cultural groups must be taken into account)

N/A

80	**Will material collected for another purpose (e.g. diagnostic use) be used?**	**Yes**		**No**	**X**
	If yes, did the donors give permission for use of their samples in this project? ***(Attach evidence of this to the application form).***	**Yes**		**No**	

If no, describe how consent will be obtained. Where the samples have been anonymised and consent cannot be obtained, provide justification for the use of these samples.

81	**Will any samples be imported into New Zealand?**	**Yes**		**No**	**X**

If yes, provide evidence of permission of the donors for their material to be used in this research.

82	**Will any samples go out of New Zealand?** **If yes, state where.** ***(Note this information must be included in the Information Sheet)***	**Yes**		**No**	**X**
83	**Describe any physiological tests/procedures that will be used.** **N/A**				
84	**Will participants be given a health-screening test prior to participation?** ***(If yes, attach a copy of the health checklist)***	**Yes**		**No**	**X**

Reminder: Attach the completed Screening Questionnaire and other attachments listed in Q5

SECTION M: DECLARATION (*Complete appropriate box)*

ACADEMIC STAFF RESEARCH

Declaration for Academic Staff Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. My Head of Department/School/Institute knows that I am undertaking this research. The information contained in this application is to the very best of my knowledge accurate and not misleading.

Staff Applicant's Signature _____ **Date:** .....

STUDENT RESEARCH

Declaration for Student Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and discussed the ethical analysis with my Supervisor. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants.

The information contained in this application is to the very best of my knowledge accurate and not misleading.

Student Applicant's Signature ..... **Date:** .....

Declaration for Supervisor

I have assisted the student in the ethical analysis of this project. As supervisor of this research I will ensure that the research is carried out according to the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants.

Supervisor's Signature _____ **Date:** .....

Print Name _____

GENERAL STAFF RESEARCH/EVALUATIONS

Declaration for General Staff Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and discussed the ethical analysis with my Line Manager. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. The information contained in this application is to the very best of my knowledge accurate and not misleading.

General Staff Applicant's Signature ..... **Date:** .....

Declaration for Line Manager

I declare that to the best of my knowledge, this application complies with the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and that I have approved its content and agreed that it can be submitted.

Line Manager's Signature _____ **Date:** .....

Print Name _____

TEACHING PROGRAMME

Declaration for Paper Controller

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. I understand my obligations and the rights of the participants. I agree to undertake the teaching programme as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants.

My Head of Department/School/Institute knows that I am undertaking this teaching programme. The information contained in this application is to the very best of my knowledge accurate and not misleading.

Paper Controller's Signature ..... **Date:** .....

Declaration for Head of Department/School/Institute

I declare that to the best of my knowledge, this application complies with the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and that I have approved its content and agreed that it can be submitted.

Head of Dept/School/Inst Signature _____ **Date:** .....

Print Name .....

Bridging Learning Analytics with Xorro-Q tool: An Institutional Dashboard Strategy (Appendix C)

Consent Form for students

Name of student: ……..

I have read the information sheet regarding this research and have had an opportunity to ask any questions about the research and have them answered to my satisfaction. I also understand that I may ask further questions at any time.

I understand that:

My participation in this study is voluntary.

The information I share will be confidential.

The information I give will be used to investigate the relationship between engagement of students in the class and their course outcomes.

No one except the researcher and the supervisors team will have access to the data

I agree to participate in this study under the conditions set out in the Information Sheet.

I agree to take part in this research.

Researcher: Shadi Esnaashari

PhD student

(Email: S.Esnaashari@massey.ac.nz)

Signature of student: ……
Date:……

Name and Surname: ……

Bridging Learning Analytics with Xorro-Q tool: An Institutional

Dashboard Strategy (Appendix E)

Consent Form for staff

Name of staff member: ……..

I have read the information sheet regarding this research and have had an opportunity to ask any questions about the research and have them answered to my satisfaction.

I understand that:

My participation in this study is voluntary.

My information will be confidential.

No one except the researcher (Shadi Esnaashari) and the supervisory team will have access to the data.

Appropriate pseudonyms will be used to ensure confidentiality is maintained.

The information I give will be used to investigate the relationship between engagement of students in the class and their course outcomes.

I can ask for the recording to be turned off at any time of the interview.

The recordings will be destroyed by the researcher three years after the study is completed.

Researcher: Shadi Esnaashari

PhD student

(Email: S.Esnaashari@massey.ac.nz)

I agree to take part in this research.

Signature of staff member ……

Date……

Bridging Learning Analytics with Xorro-Q tool: An Institutional

Dashboard Strategy (Appendix D)

Consent Form for students

Name of person: ……..

I have read the information sheet regarding this research and have had an opportunity to ask any questions about the research and have them answered to my satisfaction.

I understand that:

My participation in this study is voluntary.

My information will be confidential.

No one except the researcher (Shadi Esnaashari) and the supervisory team will have access to the data.

Appropriate pseudonyms will be used to ensure confidentiality is maintained.

The information I give will be used to investigate the relationship between engagement of students in the class and their course outcomes.

I can ask for the recording to be turned off at any time of the interview.

The recordings will be destroyed by the researcher three years after the study is completed.

Researcher: Shadi Esnaashari

PhD student

(Email: S.Esnaashari@massey.ac.nz)

I agree to take part in this research.

Signature of student……

Date……

Bridging Learning Analytics with Xorro-Q tool: An Institutional Dashboard Strategy

Information sheet for students (experiment1, experiment 2, experiment 3 for experimental group not for control group)(Appendix B)

Researcher: Shadi Esnaashari

Researcher Introduction

I am Shadi Esnaashari, a PhD student in the School of Engineering and Advanced Technology at Massey University, Auckland. To fulfil my PhD degree I would like to conduct the following research study.

Project Description and Invitation

In my research, I am exploring the interaction between teachers and students through an audience participation tool (i.e. Xorro-Q) in order to identify how we can increase the engagement of students in the class through this tool and see whether or not increasing the student engagement relates to the students' course outcome. It is hoped that by conducting this research we can design a new dashboard for Xorro-Q which could help both students and teachers in the process of learning. I would like to invite you to participate in this research study. There would be no criteria for choosing the students except students need internet enabled devices to participate in this study. We also do not exclude any students from this study unless otherwise stated by the students themselves. There is no payment for the participants in this study. There is no extra time requested from the participants. Study participants will follow the lecturer taking part in the activities.

Project Procedures

I will use the data gathered through Xorro-Q and Stream. This data are about your participation in the class, attendance, your scores, assignments and the data from survey questionnaire that you are going to participate at the end of your class for the purposes of this study. Xorro-Q is safe to use. The data are automatically collected and stored safely in the Xorro-Q data base which is in cloud in Amazon servers in Australia. Massey University has already purchased Xorro-Q for the classes in the university. We also use pseudonyms when we are using the students' data. Thus,

confidentiality, privacy, and identity of the students will be maintained. We do not require that you do any extra activity.

Data Management

All the data regarding your participation rate will be gathered through Xorro-Q and stored securely in Amazon cloud servers. In my reports on this research, I will use pseudonyms to keep your identities and responses confidential. Any audio recordings made will be destroyed after the research is completed. Written materials such as field notes and transcripts will be kept in locked cabinets during conduct of the study and will be destroyed three years after the completion of the research. Any publication from this study will ensure that anonymity and confidentiality of participants are maintained.

We will use your data regarding your attendance, and scores to understand the relationship between student engagement in the class and course outcome. After the data are analysed a summary of the findings will be emailed to you. There would not be any conflicts of interest or risks arising from participation in this study. We will anonymize the data and use pseudonym in order to preserve your identity.

If you decide to participate in the interview, the recording will be kept at Massey University lock draws. You can ask to delete whatever section of your recording or you can decline to answer any question you dislike.

Participant Identification and Recruitment

Participation in this study is voluntary. To participate, you must have an internet enabled device like mobile phone, computer, iPad etc. If you do not agree to participate, you can contact me to remove your data from this study before the end of data collection for any reason. Any publication from this study will ensure that anonymity and confidentiality of all participants are maintained.

You can choose to withdraw from the study anytime up to two weeks after the end of the data collection. If you do not agree to take part in my study, you do not need to sign the consent form. Even if you choose to use the tool you are not required to participate in the study. You can inform me and I will delete your data from my research study.

I would also like to interview some students to discuss their expectations and how satisfied they are with the tools used in the classroom. I may contact you for the interview through email. The interview is voluntary, and you are in no way obliged to give an interview; however, I can assure you that no questions of a personal nature will be asked. For the interview, the first two students who respond to our request will be interviewed. You are free to refuse if you do not wish to be interviewed. The interview will ask about your views in regard to using audience interaction tools (Xorro-Q) in classroom teaching and will take approximately 15 minutes. The interview will take place in the university premises anywhere that is

more comfortable to you. The interview time would be anytime between 9:00 am and 5:00 pm again at your convenience. If you are stressed about any question, you can refuse to answer it. In case of any stress/ discomfort please let me know and I will stop the interview. Also please be aware that Massey University Counselling Centre (Level 2, Student Central, Albany) has counselling services available for all students.

Participant's Rights

If you decide to participate, you have the right to:

decline to answer any questions,

withdraw from the study until two weeks after the end of data collection,

ask any questions related to the study,

be given access to the findings of the research when it comes to concluding.

If you are also willing to participate in the interview, you have the right to ask that the recorder be turned off or ask to delete some part of the interview. In the anonymous survey questionnaire you have the right to not answer any particular questions.

Project Contact

Please be informed that you can contact the researcher and/or supervisors if you have any questions about the project

Researcher's Name: Shadi Esnaashari (PhD student) **Date:**

Researcher's Email: S.Esnaashari@massey.ac.nz

Supervisors:

Dr Anuradha Mathrani, Senior Lecturer, School of Engineering & Advanced Technology, Email: A.S.Mathrani@massey.ac.nz

Prof Paul Watters, Professor in Information Technology, School of Engineering & Advanced Technology, Email: P.A.Watters@massey.ac.nz

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern, Application __/__ (insert application number). If you

have any concerns about the conduct of this research, please contact Dr Andrew Chrystall, Chair, Massey University Human Ethics Committee: Northern, telephone 09 414 0800 x 43317, email humanethicsnorth@massey.ac.nz.

Bridging Learning Analytics with Xorro-Q tool: An Institutional

Dashboard Strategy

Information sheet for staff members (experiment1 and experiment2) (Appendix A)

Researcher: Shadi Esnaashari

Researcher Introduction

I am Shadi Esnaashari, a PhD student in the School of Engineering and Advanced Technology at Massey University, Auckland. To fulfil my PhD degree I would like to conduct the following research study.

Project Description and Invitation

In my research, I am exploring the interaction between teachers and students through an audience participation tool (i.e. Xorro-Q) in order to identify how we can increase the engagement of students in the class through this tool and see whether or not increasing the student engagement relates to the students' course outcome. It is hoped that by conducting this research we can design a new dashboard for Xorro-Q which could help both students and teachers in the process of learning. I would like to invite you to participate in this research study. In order to participate in this study you need to use Xorro-Q in your classes. You also need to teach the whole length of the class. This tool will collect the information regarding student participation in the activities in the class whenever you ask question(s). If you agree to participate in this study, then I will ask you to upload the information sheet on the course website. I will come to visit the class and distribute the information sheet to students and tell them about the tool that the lecturer is going to use in the class. I will also tell them that all their data will be anonymised and this study will look at overall student performances. For further information, I will distribute the information sheets in the class. I will give the student the consent form so that students can sign it if they are willing to participate in the study. Next, at the end of the semester I need to interview only two students and you as a lecturer of the class. However, only those students who have an internet enabled devices can participate in this study. I will ask about overall experience in using the tool. Therefore, I will come to the class again and ask for participation of students and if they agree to participate, I will give them a consent form to sign. Then, I will conduct a 15 minute interview with the students and 30 minutes interview with you to gain some understanding on how students felt with the use of real-time audience interaction tools in classrooms.

The students can choose to withdraw from the study anytime until the end of the data collection phases. If the students do not agree to take part in my study, they do not sign the consent form. Even if the student chooses to use the tool he/she is not yet required to participate in the study. Therefore, he/she can inform me and I will delete their data from my study.

I am not requesting any changes to your teaching pedagogy. I only request you to use Xorro-Q alongside your teaching. There would be no criteria for selecting the students. We also do not exclude any students from this study unless otherwise stated by the students themselves. There is no payment for the participants in this study. There is no extra time requested from the participants. Study participants will follow the lecturer taking part in the activities.

Project Procedures

I will use the data gathered through Xorro-Q and Stream. This data are about students' participation in the class, attendance, their scores, assignments, and the data from survey questionnaire that students are going to participate at the end of their class for the purposes of this study. Xorro-Q is safe to use. The data are stored safely in the Xorro-Q data base which is in cloud in Amazon servers in Australia. Massey University has already purchased Xorro-Q for the classes in the university. We also use pseudonyms when we are using the students' data. Thus, confidentiality, privacy, and identity of the students will be maintained. At the end

of the course I will request you for the final score for students who have given their consent. I will prepare the list of students who gave their consents but I also request you to provide new codes for students to maintain anonymity of students. I also request you to give students an assignment based on the subject thought at the end of each 6 weeks of your teaching. This will not be marked and included in the final grades, rather will help me to understand how the student has progressed.

Data Management

All the data regarding your students' participation rate will be gathered through Xorro-Q and stored securely in Amazon cloud servers. In my reports on this research, I will use pseudonyms to keep students' identities and responses confidential. Audio recordings will be destroyed after the research is finished. Written materials such as field notes and transcripts will be kept in locked cabinets during conduct of the study and will be destroyed three years after the completion of the research. Any publication from this study will ensure that anonymity and confidentiality of participants are maintained.

We will use the data regarding your students' attendance, and scores to understand the relationship between student engagement in the class and course outcome. After the data are analysed a summary of the findings will be emailed to you and your students who have participated in this study. There would not be any conflicts of interest or risks arising from participation in this study. We will anonymize the data and use pseudonym in order to preserve your identity.

If you decide to participate in the interview, the recording will be kept at Massey University lock drawers. You can ask to delete any section of your recording or you can decline to answer any question(s) you dislike.

Participant Identification and Recruitment

Participation in this study is voluntary. Students must have an internet enabled device in order to participate in this study like mobile phone, computer, tablet, etc. Any publication from this study will ensure that anonymity and confidentiality of participants are maintained.

I would also like to interview you to discuss students' expectations and how satisfied they are with the current tools I used in the classroom. I will contact you for the interview through email, but you are free to refuse if you do not wish to be interviewed. The interview will take approximately 30 minutes. The interview will take place in the university premises anywhere that is more comfortable to you. The interview time would be anytime between 9:00 am and 5:00 pm again at your convenience.

I will request you for an interview in regard to usage of this tool (Xorro-Q) in the classroom. Your participation is voluntary and you are no way obliged to give an

interview; however, I assure you no questions of a personal nature will be asked. You can refuse to answer any questions.

Participant's Rights

If you decide to participate, you have the right to:

decline to answer any questions,

withdraw from the study until two weeks after the start of data collection,

ask any questions related to the study,

access to the findings of the research when it comes to concluding.

If you are also willing to participate in the interview, you have the right to ask that the recorder be turned off or ask to delete some part of the interview. In the anonymous survey questionnaire you have the right to not answer any particular questions.

Project Contact

Please be informed that you can contact the researcher and/or supervisors if you have any questions about the project

Researcher's Name: Shadi Esnaashari (PhD student) **Date: 22nd August 2015**

Researcher's Email: S.Esnaashari@massey.ac.nz

Supervisors:

Dr Anuradha Mathrani, Senior Lecturer, School of Engineering & Advanced Technology, Email: A.S.Mathrani@massey.ac.nz

Prof Paul Watters, Professor in Information Technology, School of Engineering & Advanced Technology, Email: P.A.Watters@massey.ac.nz

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern, Application __/__ (insert application number). If you have any concerns about the conduct of this research, please contact Dr Andrew

Chrystall, Chair, Massey University Human Ethics Committee: Northern, telephone 09 414 0800 x 43317, email humanethicsnorth@massey.ac.nz.