ABSTRACT
This paper reports on a rigorous and authentic approach to advancing the use of ICTs in pre-service teachers’ professional development without focusing on the technologies but rather on exploiting new and emerging technologies in the development of professional learning networks (PLN). The emphasis of this paper is on scaffolding pre-service teachers’ journey in becoming well versed in the requirements for being a 21st century educator. Participants in this study included an entire cohort of third year student teachers (n=579). Visual artefacts reveal the breadth of students’ PLNs but also highlight the severe lack of depth in most cases. Finding show that students initially struggle to grasp the value of developing a PLN and to take ownership of the process. Their growth was typified by six phases of development. This article elaborates on the derivation of these six phases.

Keywords: Professional learning networks, emerging technologies, ICTs, Online

INTRODUCTION
To be an educator in the 21st century requires competencies as articulated in various Information Communication Technologies (ICT) competency teacher frameworks such as the UNESCO (2011) and the International Institute for Capacity Building in Africa(2012) reports. Teachers are encouraged to become digitally literate, develop a deeper understanding of ICT in Education issues, integrate technology into everyday teaching and learning, use complex tools to deepen knowledge and employ technology for professional learning.

Anderson (2010) also emphasises competencies such as collaboration, knowledge building, self-regulated learning, and skilled communication. Pre-service teachers inhabit a rather unique position midway between being a learner at school and that of an in-service professional teacher. As young people and learners at school these students forged online identities free from the burdens of professional life. As pre-service teachers they become aware of the need to become
more responsible in their online conduct and to not only develop professionally but also to promote and model their future responsibilities as the “ethical and responsible use of the technology is also an added responsibility of 21st century teachers (UNESCO-IICBA, 2012, p. 19)”. As early as 2002 teacher education institutions were encouraged to develop strategies and plans to “enhance the teaching and learning process within teacher education programmes and to assure that all future teachers are well prepared to use the new tools for learning.” (UNESCO, 2002, p. 13)

**THE BROAD EDUCATIONAL APPROACH**

At the University of Johannesburg every aspect of pre-service teacher training is infused with ICTs and students are encouraged from their first year to engage with technology for formal and informal learning purposes in the module *Computer Skills for Teachers*. In the third year of studies all students are required to complete a semester module *Professional Studies* in which the use of ICT in teaching and learning is enacted in a paperless environment that is hosted in large computer venues containing 280 desktop computers connected to the internet. Lecturers conduct the classes using various cloud based services. Each student has access to their own computer and can complete activities individually or co-construct digital artefacts as part of an online collaborative group. Lecturers team-teach and interact with each other, tutors and students using various pedagogical strategies. If a specific aspect needs to be reinforced or clarified, technology is available to broadcast the lecturer’s desktop screen to every student screen. This is done at short intervals ensuring that all students remain on track and on task.

In this third year module we introduce theoretical frameworks that underpin the use of technologies for teaching and learning at an undergraduate level to pre-service teachers. We also focus on the actual use of these technologies for teaching and learning. We are aware that undergraduate students sometimes struggle with the complexities of theoretical constructs. In many cases students may not have had the opportunity to read and engage with theory in other undergraduate modules pertaining to ICT in education. For this reason, grounding this educational technology module in theory was carefully conceptualized and planned. On the one hand there is the risk of losing students through unnecessary complexity and on the other, the use of insubstantial theories that may possibly not suitably address the issues at hand. To compensate for this we introduced students to the basic principles of selected theories that underpin the use of technologies in teaching and learning.
The first theoretical construct deemed useful in this module is the Vygotskian concept of tool mediation. The Vygotskian actor-object-tool triad was presented and simply described as a precursor to Cultural Historical Activity Theory or CHAT (Engeström, 2001; Engeström, Miettinen, & Punamäki-Gitai, 1999). The complexities of CHAT, where tools mediate activities within contexts that include Community, Division of Labour and associated Rules (Barab, Evans, & Baek, 2004) were not addressed in much detail but students were made aware that tool mediation is part of a greater body of knowledge. Theoretical constructs were dealt with gradually as students were exposed to the notion of technology functioning as the mediating tool throughout all learning activities in the module. In these learning activities, the focus was not on the technology (as object in an activity theory context) but rather on the learning where the technology simply functions as the mediating tool.

The second theoretical construct useful to this module is the concept of authentic learning (Reeves, Herrington, & Oliver, 2005) as the object of the activity (in an activity theory context). The nine characteristics of authentic tasks identified by these authors are presented as a theoretical construct (within an authentic task about authentic tasks) and subsequently throughout the module in all other authentic tasks and activities. These tasks have real-world relevance that are meaningful to students and can be applied to current situations or contexts – that of pre-service teachers. These authentic tasks are suitably ill defined and open to multiple interpretations to enable students to make their own meaning of the tasks and the methods utilised to complete the tasks. Furthermore, the authentic tasks are complex enough to elicit higher order thinking and provide opportunities to include different perspectives.

One such authentic task is for each student to construct their own Professional Learning Network (PLN). Today teachers cannot rely solely on personalised workshops tailored to address specific needs and teachers are becoming increasingly responsible for their own professional learning (Amor & Yelling, 2007). The recent Horizon report (NMC, 2012) identifies personal learning environments as a key trend to be increasingly adopted within the next two years and the implication for teacher development is that each teacher can develop and harness their personal network for professional learning. The authentic task in the module was thus designed on the premise that pre-service teachers are partly responsible for their own professional development and that building an initial PLN can develop and sustain them in their future careers.
can, therefore, be described as an informal learning network consisting of groups or individuals interacting and sharing expertise, resources and ideas for professional purposes.

Ivanova (2009) suggests that students first start with a personal learning network and transition to a network that is more professionally aligned in joining special interest groups or subject matter experts. The systematic induction into online network activities in a personal space allows students to forge new connections in an environment they feel safe in before venturing into the unknown world of professional networked learning. Each PLN is unique dependent on the interests and passions of individuals within the network. Connections are forged across various tools and platforms with the intent to enrich experiences and to learn from one another. Part of building a PLN is the notion of building on the work of others. In the construction of their PLN, students are encouraged to identify tools and services that enable them to construct their own learning activities and learning resources that can be shared with other like-minded teachers in an effort to curate and aggregate resources relevant to their own subject areas. During this process resources are sourced from the nodes or connections in their PLN, critically analysed, adapted to specific contexts and repurposed with the idea of contributing it back to the broader learning community. Throughout each of the contact sessions students are exposed to a variety of tools and services, however, they are encouraged to make their own choices regarding which of them to subscribe to.

A METHODOLOGY TO INVESTIGATE THE EMERGING PROFESSIONAL LEARNING NETWORKS OF PRE-SERVICE TEACHERS

This generic case study incorporates elements of a grounded theory approach in the analysis of student’s self-reflective comments captured from an online survey. This case is defined by the following unit of analysis: students engaging in the process of creating their own PLN within a module in an undergraduate course. Trustworthiness was insured by providing a dense description of findings, making use of the actual voices of the students and a well-defined audit trail. Through a series of learning activities pre-service student teachers were guided in the process of developing their own PLN. Every week a new activity was provided to support and scaffold their journey of discovery learning. Themes included aspects of digital identity; online safety; technical aspects of managing subscriptions; and creating professional profiles. One such activity included investigating various online teacher repositories where teachers from across the
world produce resources and are willing to share their expertise with others in the network. Students embarked on discovering the riches contained in teacher repositories and existing communities of practice. Teacher repositories are well categorized and content is tagged according to levels and subject areas making accessible and reduce the time spent searching for suitable material. Teachers within the repositories have well developed profiles encouraging students to follow suit leading to greater personalization and contextualization. Student pre-service teachers identify and follow other individuals within the network whose work they admire and find useful. In this way they build a distributed network. Once they join their networks of choice, students were encouraged not only to lurk and consume resources but rather to become active members in these networks.

Their last portfolio assignment comprised a critical reflection of the PLN development process, and a digital rendition of their PLN. The data set consist of visual representations of their PLN as submitted as part of their final portfolio, and responses to a survey incorporating open-ended questions created using Google Forms and hosted in Google Drive. Students were asked to reflect on

- their strengths and weaknesses in developing their PLN.
- their underlying values and beliefs with regard to technology use in education
- their underlying assumptions about professional learning networks (PLN) as developed during this module.
- The module content, activities and possible inadequacies or areas for improvement
- What they enjoyed most about this module?

Nearly 95% of the enrolled students (n=543) completed a self-reflection activity resulting in 2715 unique responses to the above statements. The answers to each of the questions were captured in a Google Form and downloaded to a spread sheet. A grounded theory approach was used to sift through the data and code it using snippets of text as units of meaning that were formulated as codes. Grouping related codes together produced themes resulting in the articulation of seven distinct phases in the development of a PLN. The process was complicated by the rather naive perspective and pre-service status of the students as they had to rely on their emerging and incomplete subject content knowledge as well as their limited work experience and preconceived notions of what it entails to be professional.
**FINDINGS: PLN DEVELOPMENT IN NOVICE TEACHERS**

Pre-service teachers initially expressed and experienced uncertainty on introduction to the PLN concept, however, it did not take them long to realize the importance and relevance a well-developed PLN the benefits it can add to their learning and future career. Creating their own digital and professional identity as a novice teacher allowed them to start connecting with other professionals adding to the value of a vibrant PLN. The value proposition is enough of an incentive for students to take ownership of their PLN and to cultivate deeper relationships with other professionals. Once they have taken cognisance of the full implications of being professional through the exposure to peer reviewed digital learning resources contained in their PLN, they expressed their future aspirations recognising them as a vehicle for continuous professional development. Six phases as experienced by novice teachers in the development of their PLNs emerged from the analysis and are depicted in Figure 1. These six phases are sequential and in order to progress to the next phase students need to fully adopt and pass through each phase to reach self-actualization and to realise their future aspirations for their PLN.

**Figure 11: Phases in the development of Pre-service teachers’ Professional Learning Networks**

![Diagram of phases in the development of Pre-service teachers’ Professional Learning Networks]

Each of these phases is presented in more detail though the actual voices of the students.

**Face uncertainty**

Students report their initial confusion when introduced to the concept of the PLN manifesting in an uncertain phase which lasted for some time: “Initially my PLN was not that important to me, 
so I did not pay a lot of attention to it” and “When I started creating my own PLN I thought it was the dumbest thing I’ve ever heard of and I thought why would anyone use something like this and what are we as students doing it for.” Most of the students who enrolled for this module had prior knowledge of social media as up to 98% claimed to be connected to social media services. They knew how to make connections, stay in touch, interact with friends and contacts, and to stay generally informed. They did, however, struggle with collaborative tasks: “The development of my PLN has been difficult as it has forced me to interact with people out of my comfort zone” and “The first time I'd heard of it, I had thought it is another way to make varsity life difficult for us”.

Students initially indicated their reluctance to get involved in the activity of developing their PLN fearing for their privacy: “In the beginning of this course I was uncomfortable to sign up to all the networks and putting my name out there, since I am an introverted person and I like my privacy.” and the negative implications of expanding their digital footprint: “At first I did not have faith in a PLN because of the fear of putting myself on the internet, and exposing myself to paedophilia”. These fears are rooted in preconceived notions of what digital safety entails and the ignorance around taking adequate measures to protect their digital identity.

Taking cognisance of their pre-service status as novice teachers, they are still 2 years from active service in a school environment. Making the transition from engaging in a personal learning network with friends and interacting in a professional learning network is problematic for them as the notion of “being a professional” is still a distant concept: “When the PLN was first introduced in this module, I didn't quite understand the concept and thought that I will never use it after this module”. This concept is also influenced by their preconceived notions of what it entails to be a professional educator and their beliefs that they would have ample time to develop these networks: “I essentially told myself that I did not need a PLN because each person has their own teaching experience and that PLN would develop as I transitioned from being a novice teacher to a professional educator”.

**Find Relevance**

Once students developed their own profiles and started to collaborate with each other during an activity where they were tasked to co-construct learning resources in a virtual space, did they experience the positives of connecting online. “It is not only about social life (connecting with
friends) but also about building up my professional image and finally making me an effective teacher. Through engaging with others and sharing ideas and values we are able to construct things we could have never constructed on our own”. It was during this activity that they matured in their thinking and felt empowered enough to make their first professional connections. “These learning networks enable me as an up-and-coming teacher to interact and associate with other established teachers in the same subject area. I was able to interact with various important people and this enabled me to learn from the different ways of becoming a better teacher”. A sense of online collegiality gained from a distributed network first surprised and then motivated students. “It is great to actually realize how many teachers there are around the globe. To see the passion that they show towards their profession and the pleasure they receive from it”. They also revelled in learning that was not dictated by an externally set curriculum and gained new insights in different pedagogical strategies. “What I enjoyed most was learning great new ways to improve my teaching; I was inspired by all the networks for teachers. Not only did it inspire me to come up with new exiting lesson plans it also gave me a feeling that I am not alone”. Students reaffirmed to themselves the essential role they play in society and were heartened by the unifying ideals and aspirations of continuous refining the craft of teaching. “It was nice to see that teachers all over the world come together and aim to be better educators, it gave me a feeling of unity and pride, because we are not always appreciated but we do a very important job and seeing that so many different people across the world working together for the same common goal was inspiring and comforting”.

Connect and articulate stance - establish a professional identity
One of the more serious challenges students faced was to start thinking about themselves as future professionals. Explicitly articulating their professional stance requires a reflective process which does not come naturally to novice teachers. One of the requirements of joining an existing network is to compile a profile and give a short biography and declaration of interests. “The challenge was to create a PLN that suited my personality and the type of student teacher I am”. Projecting themselves as future professionals and how they would like to be perceived online was at first problematic. “When I first heard about PLNs I thought it was rather interesting, however I felt that it would not yet be relevant to me as I am still a student teacher and not yet a professional. It later come to light that many student teachers also access these networks and
quite a substantial amount of aid is available for student teachers and includes ways of dealing with learners during one's school practical”. There was also a deliberate strategy to use their PLN as a vehicle to generate future employment prospects and therefore some effort went into polishing their online profile. “I have constructed my PLN with the intention to portray a professional image of myself to enhance my career opportunities”.

Make the Transition
Sentiments suggest that once pre-service teachers understand the value of developing a PLN, there is a deliberate interaction and increased engagement in growing their PLN through connecting not only to subject area specialists, but also to forge connections in their own fields of interests. Some of the students found it difficult to develop their online PLNs and relied on the weekly activities to guide and map their progress. “I believed that my PLN would grow in a REAL way through experiences and surroundings, and not virtual as through internet. But for this to happen, I needed some kind of guidance on “how-to”, that’s when I realized that having and growing a PLN might come in handy one day”. They also started to acknowledge that their own contribution is required to service their PLN to keep it current and relevant. They found a great number of educators willing to share their expertise online which made them feel less alone. “It was very interesting on how educators all over the world can connect and be able to share ideas on how they change the everyday life of teaching and inspiring the learners and making the work easier, as a novice teacher it helps me”. Students appreciated the ability to give expression to their creativity in the articulation of their lesson designs and the unexpected benefit of being part of a wider network is to access to immediate assistance for clarification. “The personal learning network allows us to build networks where we can pursue our intellectual and creative passions with people around the world. You can also post online the topic that you do not understand and you can get help as fast as possible”. Being able to see the world of teaching not only bound by four walls but expanded and reliant on the strength of one’s connections, a shift occurred in the seriousness they approached their PLN.

Acknowledge the professional burden (Take Ownership / application -putting it to work)
Through being exposed to other professional teachers from across the globe, pre-service teachers started to see themselves as novice teachers in the process of becoming professionals. As such,
they willingly assumed roles of mentee and selected expert teachers to follow. “I really value the relationship I have with the teachers in my field of Mathematics for, they have so much to discuss and that is helpful for me to adapt to this ever-changing way of learning in Mathematics”. Mentoring is part of the induction process of becoming a professional educator as much as ongoing professional development is part of life-long learning. Once pre-service teachers realized that other teachers will use the resources created for their own teaching and learning purposes, they wanted to ensure the integrity of the artefacts. “Building a professional learning network of your own is an easy task; however ensuring that the content you upload regularly is a highly effective way of teaching or assessing learners in schools is a challenge. I had to ensure that the quality of the work I shared with other teachers is good so that they may view it and put it to use. I was very excited when I saw that over 20 people have downloaded my slides.” The nature of their interactions assumed a more formal tone and they started to question the quality of their lesson designs and digital artefacts. “It takes hard work to construct your own PLN. It also takes hard work to share things with others for example when you want to share a presentation you have to know what you talking about”.

**Self-actualization and Future aspirations**

Students were encouraged to develop a long-term plan for their PLN and to adopt habits for life-long learning. Being able to engage with others in their network and refine ideas through online interactions was constructive and matured their thinking. “I enjoyed engaging with other educators around the world, it was unreal to me at first that a person who lives far from me may be able to see my ideas, edit them and also comment on them. I was able to communicate with educators from France through the learning networks and I slowly began to see how the idea of teaching differs from region to region”. They soon realized the need to interact and engage in order to grow their network and merely lurking did not add value to their own development. “My PLN can be used to my advantage now and in my career one day to improve teaching and learning, organizing and finding useful content more effectively, and receiving constructive solutions to any difficulties I might experience as a novice teacher”. Students eventually became empowered enough to start creating their own communities focussed on issues identified within their own contexts as they realized that their perspective was unique and others could learn from their experiences novice teachers. “I realized in creating my PLN that I not only can learn from
the others but that I can give back through creating my own communities and inviting teachers to share their ideas with me and the others”. Because of the highly authentic nature of developing a personal network, the ownership and future interactions became more meaningful. What I enjoyed most about this module was being taught all about our PLN’s, as well as how we are able to use it to our advantage as well as in our classroom on a daily basis. The PLN’s that we were told to set up with stay with me throughout my entire teaching career and will only benefit me as a teacher and it will benefit my learners in my classroom environment.

CONCLUSION
We maintain that knowledge is distributed and ubiquitous in nature and that learning should increasingly occur within this borderless environment. Self-organised learning in this module encourages students to gravitate towards clusters of trust where knowledge can be sourced, shared and created. Pre-service teachers are therefore inducted into the world of online learning in a systematic way to enable them harness the power of partnerships through frequent communication with expert teachers enabling their transition to become education professionals.

In order to achieve this objective pre-service teachers are encouraged to connect with teachers from across the globe in an attempt to interact with content specialists and experience a range of pedagogical practice. These connections between individual teachers form networks that we believe can offer opportunities to share resources, collaborate, strengthen pedagogies and practices, allow for self-reflection and peer validation. No two PLNs will be the same and the unique paths of development should be directed by the needs and aspirations of the students who participate actively in the act of nurturing, maintaining and leveraging their network for personal and professional learning.

As a novice teacher it is all about understanding the professional position and to eventually become a professional educator, cultivating a spirit of sharing and generosity and connecting with the best teachers in the world whilst modelling good practice and developing a distinct teacher identity. Continuous professional development can be offered in a formal and informal way allowing for self-direction and self-organization. Though the focus remains on the personal choices enacted in creating a PLN they significantly draw on their knowledge of enabling tools and services increasingly moving to cloud-based productivity tools allowing for the creation, curation and aggregation of resources. The way PLN’s are developed and used continues to
evolve, with applications for handheld devices gaining in popularity allowing users to curate and aggregate information and resources in a coordinated and continuous way.

The final word from one of the students:

*The fact that we are able to study and engage in aspects other than content, which is of importance to build ones cognitive domain, but, we were able to craft our skills and abilities with regards to the use of ICT in education was of utmost benefit. The fact that we learned something new in every contact session was helpful in terms of building ones professional learning network. Moreover, I enjoyed the creativity that this module allows one to incorporate into assignments and work in general. Being able to reflect on this module for possible improvements was also beneficial, taken that we should always be reflective educators to be proficient teachers.*

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