ICICTE 2019

International Conference on Information Communication Technologies in Education

Proceedings

Chania, Crete, Greece – 4-6 July, 2019

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2019

The Proceedings of the International Conference on Information Communication Technologies in Education 2019

Conference Organisers:
The International Consortium for Educational Technology
Conference Sponsors:
The Commonwealth Centre for Connected Learning
Solent University, Southampton, UK
University of Ljubljana, Faculty of Public Administration

Conference Director: Nancy Pyrini
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Conference: 4 to 6 July, 2019, Chania, Crete, Greece

The International Conference on Information Communication Technologies in Education (ICICTE 2019) Proceedings

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Plenary Session 5: Digital Skill Sets and Mind Sets

PREFACE TO THE PROCEEDINGS

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«πάντα χωρεῖ καὶ οὐδὲν μένει»
“All things change and nothing remains still”
(Heraclitus as quoted by Plato in “Cratylus”)

Long before digital technology, the ancient Greek philosopher Heraclitus identified change as a fundamental characteristic of the universe. Approximately 2,500 years later, as we gather for the 19th annual International Conference on Information Communication Technologies in Education (ICICTE), we can both embrace his pronouncement and also enhance it by insisting that there is one principle that, for us, will never change: a deep-rooted belief in the value of education to transform lives and make the world a better place.

We are here because we believe in education and we believe that information communication technologies can help us “do” education better.

The process of producing these proceedings is a case in point. I am writing from my home in North Canton, OH, and in the past few weeks, from work and home, have exchanged countless e-mails across multiple time zones with Ġorġ Mallia in Malta (whose name, which includes characters that do not appear on my English-language keyboard, I have copied from his e-mail signature), with Nancy Pyrini in Greece, and with conference participants on five continents. These e-mails have included: my requests for revisions and pleas for more time; from Ġorġ, guidance and requests for deliverables (and he will achieve sainthood, I’m sure, based upon my pleas for more time); and from Nancy, reminders and requests for schedule adjustments based upon the personal situations of specific participants (her heart is as big as her intellect). It is difficult to imagine how this process operated nineteen years ago when ICICTE began; it is impossible to imagine how this communication would have taken place 2,500 years ago.

Just as advances in technology help us communicate more efficiently and more rapidly, they can help us teach and learn more successfully. The principles of Universal Design for Learning are especially relevant: 1) Multiple Means of Representation, e.g., instructional materials in multiple formats that can be accessed anytime, anywhere, on different devices; 2) Multiple Means of Expression, e.g., ways for learners to demonstrate their achievement of learning objectives, including videos, podcasts, presentations, debates, visual art, wikis, discussion forums, and more traditional methods of writing; 3) Multiple Means of Engagement, e.g., enhanced engagement and communication, including research-based projects, social media, collaboration tools, peer assessment, and virtual events. How do we know whether specific strategies have been effective? ICT allows us multiple means to evaluate the success of our pedagogical strategies, through both formal controlled studies and also analysis of student access to materials and activities via learning analytics. Finally, how do educators learn about the resources, strategies, and methods of evaluation that will work for them? When "all things change"—and technology will always be a moving target—professional development (PD) becomes especially critical. Even the means of PD is changing: in addition to academic publications and conferences such as this one, educators can benefit from educamps, simulations, and experiential learning. All of these resources, strategies, methods of evaluation, and innovative PD opportunities are touched upon by papers in these proceedings.

But technology can also create barriers. Sharing content in a multimedia format might make information inaccessible to certain groups, as can utilizing text that is not optimized for accessibility. In closely reviewing APA style (6th edition, dating from 2009) before updating the manuscript guidelines for our conference, I discovered that APA style is not fully accessible. It appears to be based upon the capacity of a basic manual typewriter, on which it would be impossible to change font size, create vertical lines on a table, or select a different color, let alone provide metadata for an image. Therefore, this year's guidelines departed from strict APA format. I salute the authors who sought to comply with the new guidelines and sincerely hope authors and readers alike will strive to create accessible documents and help grow a culture of accessibility in the future.

Aside from potential barriers, technology can also bring risks. A growing concern is the need to educate digital natives about information literacy so that they are discerning about the information they access and the individuals they interact with online. We can teach them how to use devices. Can we teach them how to stop using devices? Can we guide them to use technology mindfully, being mindful both of what they are doing and also of what they are not doing because they are too caught up having their heads down? And, can we teach them to protect themselves against "the dark side" of the cyberworld just as they need to protect themselves against dark elements in the real world?

That is why this conference exists. It brings together kindred spirits who are passionate about education, excited about technology, daring enough to take risks, and generous enough to freely share successes, failures, and ideas with others. Because all of us want to "do" education better, and all things change.

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ICT IN TEACHER EDUCATION: EDUCAMPS AND PEER LEARNING

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Abstract

Educamp is an event where participants share possibilities of software tools and network with each other. This method has been used at the University of Iceland (UI) from 2014 to the present in a course on Information Communication Technologies (ICT) for undergraduate teacher students who are earning a B.Ed. degree. They submitted reflections about their contributions and experiences. Most rated the educamp as interesting/fun and felt they had learned much. Participants enjoy and learn from the educamp method to reflect and think about using ICT in education. The method can be recommended as a way to increase ICT competences of teacher students.

Introduction

There is a need to focus on ICT competences in teacher education (European Commission, 2019; Gudmundsdottir & Hatlevik, 2018). At the University of Iceland – School of Education (UISE), various methods, including educamps, have been used for that purpose with different groups of undergraduate and graduate students as well as practicing teachers for professional development. Educamps have been organized as independent events or as course modules for these groups. In this paper, the focus is on their use in an undergraduate course on ICT in education for teacher students.

Educamps: Definitions and Use

Hale and Bessette (2016) describe an unconference as "a less-structured opportunity for participants to learn and grow by sharing individual expertise in a variety of ways that reflect participant interests, preferences, skill sets, and needs." Unconferences have been used for many years involving different kinds of participants, and other labels have also been used for such events where educators are the target group. Leal Fonseca (2011) used the term educamp for a face to face (f2f) event focused on ICT and described it as "an unstructured collective learning experience" (p. 60) where participants can share possibilities of software tools and network with each other. The term "edcamp" has also been used by (Carpenter, 2016; Carpenter & Linton, 2018; Carpenter & MacFarlane, 2018) and it is seen as a "typically voluntary, participant-driven unconferences for educators" (Carpenter & MacFarlane, 2018, p. 71). Other labels include "playdate" (Schlesinger, 2017) and "teachmeet" (Turner, 2017). The term "educamp" used by Leal Fonseca is used here because his article provided an inspiration for several educators in Iceland to start organizing educamps in 2012 involving teachers or teacher students. The term educamp was translated into Icelandic as *menntabúðir* and it has now spread and become popular around the country for various groups and even with students at the primary or secondary level. These types of events appear to be working very well as a method in professional development related to ICT in teaching and learning in Iceland (Jakobsdóttir, 2015; Ástvaldsdóttir, in press) and in other countries (Leal Fonseca, 2011; Carpenter, 2016; Carpenter & Linton, 2018; Carpenter & MacFarlane, 2018). In this paper, I will describe how the method can also be used with positive results in teacher education when participation is not voluntary. Earlier findings have focused on the experience at the University of Iceland 2014-2017 (Jakobsdóttir, 2018) but in this paper I will also include findings from 2018-2019.

Project Description

In this section the educamp module is described, its goals and the preparation phase, the event itself, and the online contributions from the students, as well as their evaluation of the module. In addition, an overview is provided of the participating student cohorts.

The Educamp Module

The educamp module was integrated in a five ECTS (European Credit Transfer and Accumulation System) distance education introduction course on ICT in education. The course description is the following for the current academic year:

> What is information and communication technology (ICT) and what could be its effects on education in the future? When did computer use start in Icelandic schools and how has the digital landscape “developed in schools? How does the national curriculum for compulsory schools present ICT as a special subject and across other subjects and how does it link to key competences and fundamental education pillars? Current national and global issues and trends in relation to ICT in teaching and learning will be explored. In addition, key research and theory will be introduced which could be applied when planning students’ learning experiences with ICT. Participants test and evaluate software, digital educational resources, and tools, and link technology and pedagogy to plan activities or projects for students at the compulsory level. The focus is also on the teacher as a professional and on opportunities for professional development about and with ICT and social media linked to teachers’ communities of practice. Emphasis is on a formation of an inquiry-oriented learning community which will focus on the above subjects, sharing ideas and experiences about challenges and opportunities associated with ICT use in education. (University of Iceland, 2018).

The course is mainly taught online (using Moodle) but includes two face-to-face meetings during a 14-week semester in January to April. The module counted as 10% of the final grade (involving 12-15 hours of work). The goals were the following:

- understand the value of peer learning, sharing experience, knowledge and ideas about ICT use in learning and teaching;
- understand the importance of professional development in ICT and opportunities and possibilities to keep up with changes and innovation;
- widen the professional network among fellow students and teachers regarding the use of technology and pedagogy, and
- increase knowledge about the use of ICT and development of associated teaching methods.

Students prepared for a face-to-face educamp event organized during the second campus session (at the end of March) by reading research papers available in the Moodle Learning Management System and watching recordings as introduction to the topics. They could access resources gathered by earlier cohorts and student groups and lists of useful ICT tools as well as models of ICT use and pedagogy in teaching and learning. In the week before the event, they provided preliminary information about their presentations in a wiki document which facilitated the organization during the educamp event. The wiki provided information about what they were going to introduce and with whom if they wanted to work in pairs or small groups. In 2018 and 2019, the introductions were categorized by subjects (e.g. foreign languages, math) or more generally cross-curriculum and/or ICT. The teacher then made a preliminary schedule one or two days before the event, evenly dividing the listed presentations into three periods. This schedule was online (in Googledocs in 2018 and 2019) and participants could easily make changes to the document before and during the event. Each two-hour event was divided into three main parts.

1. Preparation period (10-15 minutes): Finalizing the schedule.
2. Main part (90 minutes): Peer learning, divided in three periods
3. Wrap-up (10-15 minutes): Discussion of the project and experience

The educamp event started with 10-15 minute preparation period where the schedule was reviewed and changes made when necessary. A few students had changed their minds about what they wanted to introduce. Some had neglected to provide prior information about their introduction, and others needed to change their introduction to a different period. In some years, this period included a brief introduction to additional presentations from university staff members or outsiders that might be invited to the event, for example related to other projects in the course such as coding (see Figure 1). Participants could also ask questions if something was unclear about the procedure.

Figure 1. Educamp 2018. Guests in the preparation phase.

The main part of the event, involving the peer learning, was divided into three half hour periods (1, 2, 3). About 1/3 of the whole group was in a teacher role during each period, with teacher students distributed among numbered tables/stations in the classroom(s). During each period, about two thirds of the group were in a student role and could choose from which peers (or additional visitors) they wanted to learn. They were required to visit at least five stations when in a student role but could choose how long they stayed, whether to visit many fellow students briefly or fewer peers for longer time during each half hour session. Teacher students showed their peers different types of digital learning tools, discussed with, and learned from each other. Figures 2, 3 and 4 display over-the-shoulder peer learning during educamps in 2019.

Figure 2. Educamp 2019. Individual presentation with three peers.

Figure 3. Educamp 2019. Discussing Google Classroom and Kami with peers.

Figure 4. Educamp 2019. Showing Lingohut to several peers.

Finally, the educamp event concluded with a 10 minute wrap-up period with a whole group discussion about the educamp project. The participants expressed their thoughts and experiences and could ask questions about their online contributions.

The days after the educamp event, the teacher students sent information and reflections about their own presentations and experiences. Some of the students in the course were unable to attend the campus session. To complete the module, they were required to send in information and reflections about two digital tools (instead of one that had also been presented during the event). All the presentations were made available as a learning resource (pdf document and/or a wiki) for the students in the Moodle LMS.

In addition, students were required to send in reflections online about five visits to other students during the educamp event. They were also invited to rate the educamp project where they indicated how much or little they had learned and how interesting/fun the project had been. Finally, they could add comments in an open-ended question. Those who had not been able to attend the event wrote about five selected presentations from the learning resource described earlier.

Participants

Most of the course participants were in their second semester (spring) in an undergraduate teacher education program in the course in which the educamp module was embedded in 2014, 2015, 2016, 2018, and 2019. The number of participants each year in the educamps ranged from 36 to 80. The majority of the students registered in the course were women (75-81%).

Table 1

Overview of participants in the educamp module and survey by year

Participants Information		**Year**				
		2014	**2015**	**2016**	**2018**	**2019**
Course	**Number of students**	113	109	96	100	48*
	Female: Male (F:M) ratio	80:20	78:22	77:23	81:19	75:25
	Mean age (age range)	27 (20-58)	30 (20-57)	27 (20-52)	28 (20-61)	32 (21-62)
	Course completion rate	85%	79%	83%	83%	NA*
Survey	**N (females, males)**	88 (77F, 11M)	72** (60F,10M)	70 (55F,15M)	81** (66F,12M)	34 (28F,6M)
	Survey completion rates total (females, males)* **	78% (86%,48%)	66% (71%,42%)	73% (74%,68%)	81% (81%, 63%)	71% (77%,50%)

Notes. *In 2019, a new department division was in effect which influenced the number of students registering for the course; the course was not completed when this paper was submitted in April.
**In 2015 two did not identify gender, and three did not in 2018.
***The rate is based on the total number of students originally registered for the courses. Most students completing the course and the educamp module completed the survey.

As can be seen in Table 1, there were considerably fewer students in the ICT course in 2019 than in earlier years. The reason was a new department division, as teacher students preparing to teach in the early years were in a different department.

Results

Table 2 displays participation in the educamp module during the event itself and in terms of contributions about tools/software submitted online after the event. During the event there were 32 to 84 students who presented at 17 to 53 stations. Eight to 25 did so individually, but others in pairs or smaller groups of 3 to 4. Number of contributions sent in online from students ranged from 38 to 73 about 30 to 66 digital tools, software and/or e-learning materials. Examples of the tools included digital portals in Icelandic, educational games or drill and practice in language learning or Mathematics, digital maps in Geography, social media, question games, flashcards, music making, and tools for multimedia production and online communications.

Table 2

Participation by year

Project part	Participation	2014	2015	2016	2018	2019
The Educamp event	Number of stations/presentations	45	53	36	40	17
	Number of teacher students	71	84	65	72	32
	Number of individual presenters	24	25	15	12	8
	Number of pairs	16	26	13	18	5
	Number of groups with 3-4 members	5	2	8	8	4
Online contributions	Number of contributions sent online	73	72	62	73	38
	Number of tools/software	52	51	49	66	30
	Number of students with online contributions	80	76	57	80	35

The students tended to rate the experience as ***very** interesting/fun*, with a large majority (73-85%) agreeing. All others said it was ***considerably** interesting*/fun (Figure 5). Furthermore, a large majority thought they had *learned much* or *very much.* Totals for these two categories ranged from 79 to 89% (Figure 6).

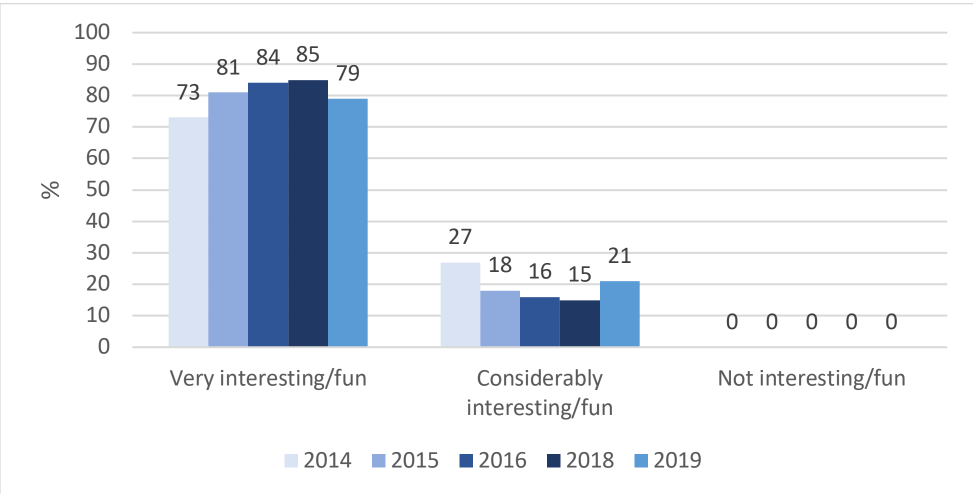

Figure 5. Students' ratings of the educamp event regarding how interesting/fun.

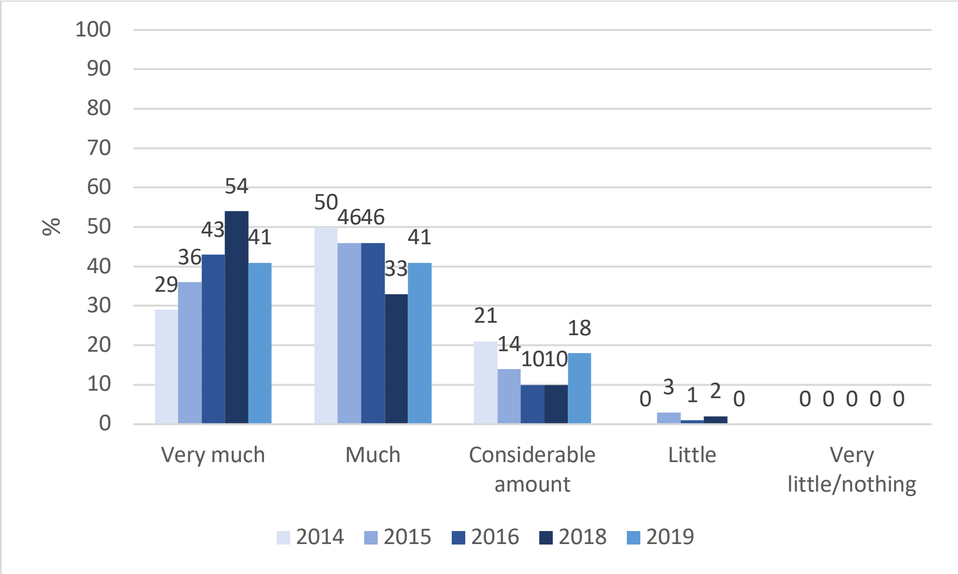

Figure 6. Students' ratings of the Educamp event regarding learning.

Participants were invited to respond to an open-ended question asking for additional thoughts. Many emphasized that they had really enjoyed the event and several said that they had learned something new they felt was useful. Some indicated appreciation for this type of peer learning. Here are some examples of comments from the 2018 cohort (translated by the author).

> I think it was a lot of fun and it went well. (Male, early 20's)
>
> I thought it was very fun and many interesting programs one can use in teaching and at home. We are of course here talking about the future and programming for example. (Female, early 40's)
>
> This was very interesting, I learned many new things and it was fun to try this type of teaching, I am happy with this day. I would have liked to participate in more introductions but there was just not time to do that but within each intro they were often introducing more than just one app or website. (Female, early 30's)
>
> The time went incredibly quickly and I would like to get to do this again and get to know even more software that you can apply in teaching. Also I would like to have more courses with educamps where one can get to know various things related to school work (learning materials / teaching methods). (Female, late 30's)
>
> This was a really big surprise for me, was stressed beforehand but my introduction went really well and I learned an incredible amount. I saw there and learned about software and websites I would never have discovered on my own!! Very cool and could be used in more courses. (Female, early 30's)
>
> I thought it was great that we could share informally our experiences about [ICT] implementation in our work. It is good to be able to ask and get an immediate answer. In addition it was good to chat with other teacher students. It would have been good to get more time. (Female, early 40's)
>
> I thought the experience was very good and it was fun to get a chance to teach others something one knows about but others don't. Everyone I met was really happy with my introduction and it made me happy. (Female, early 20's)

> …The more communication teachers have and the more they reflect on their work the better chance for them to improve what they think is important… (Male, early 60's)

> Generally very interesting and I can imagine that I will be able to apply a lot of what I learned about in my own teaching. (Male, late 20's)

Suggestions for improvement included that it would be better to have the event in just one classroom and better to have it earlier in the day. (The last two years, the event took place on a Friday afternoon from 13:00 to15:00). Some students have family and time pressures, for example picking young children up from daycare.

In the earlier years (before 2018) there was a tendency (a significant positive correlation) for ratings of the project both regarding enjoyment and learning to improve longitudinally (Jakobsdóttir, 2018), which may have indicated that the organization of the event was getting better. However, the ratings dropped a bit in 2019 both regarding interest and learning (see Figures 5 and 6). This may have been due to the big decrease in the number of students attending the event and therefore less variety in the ICT introduced and fewer opportunities than in earlier years to learn something new. Also, in earlier years the educamp module was introduced in the earlier campus session, which was not the case in 2019. Still, there were predominantly positive responses from the last cohort.

Discussion

The results of this project show that teacher students enjoy learning with peers in educamps, which encourage them to reflect and think about using ICT in education. The method can be recommended as a way to increase ICT competences of teacher education students. Educamps for teachers around Iceland have become increasingly popular (Ástvaldsdóttir, in press) for professional development as special events or as part of conferences or courses arranged by various associations, municipalities or schools. There is obviously high interest to develop the method further with different groups to facilitate a culture of sharing and inquiry in the teaching profession. Introducing the method to teacher students early in their studies could make them more aware of possibilities to continue learning new skills from their peers in the future as well as to share their own expertise.

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PEDAGOGICAL SIMULATION AS A TOOL FOR PROFESSIONAL DEVELOPMENT AMONG INTERNS IN TEACHING

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Abstract

This study was carried out in a mixed approach of qualitative and quantitative methodology in order to examine the satisfaction of intern-teachers with a simulation-based learning method. It presents participants' perceptions regarding a simulation workshop's contribution to the professional development of beginning teachers. Findings indicate remarkable satisfaction of the participants with the simulation-based learning method. They perceive the simulation as an effective learning method that contributes to acquiring communication skills and assists in conflict resolution and analysis of classroom scenarios. It contributes to their professional development and, therefore, they suggested an increase in their participation in the simulation workshops during their internship process.

Introduction

The use of simulation and research as a means for training professionals is growing in recent decades, mainly in the fields of flying, medicine and senior executive training. Simulation is the imitation of the operation of a real-world process or system over time. The act of simulating something first requires that a model be developed; this model represents the key characteristics or behaviors/functions of the selected physical or abstract system or process (Banks, Carson, Nelson, & Nicol, 2010). The researchers also assert that the model represents the system itself, whereas the simulation represents the operation of the system over time. Simulation is used in many contexts, such as simulation of technology for performance optimization, safety engineering, testing, training, education, and video games (Gray & Rumpe, 2016).

Simulation-based learning is a teaching method integrated with a variety of academic courses, which enables a learner to experience an authentic simulation of educational situations designed in advance according to the goals of the course. Students in the simulation participate in a variety of roles, such as executives, employees, authorities, judges, economists, government members, and various stakeholders. They deal in a controlled manner with dilemma and conflict situations, with different learning modes and unexpected challenging events taken from the professional world.

The National Centre for Simulation in Education in Israel was established in 2012 due to the group effort and cooperation between the Teaching Workforces, the Practical

Training Department and the Professional Development Administration of the Ministry of Education in Israel (Israeli Ministry of Education, 2012). By operating professional actors, the Centre offers a unique simulation learning experience. The actors play the role of the main characters of the event which reflects the daily life experiences of teachers in order to stimulate quality teaching and education achievement based on the personal dimension of these interactions. This is expressed through the use of language and communication skills that enable teachers to use their professional knowledge in the best appropriate way (Eizenhamer, 2016).

The events used in the simulations focus on the dynamics of conflict transformation and the practice of interpersonal communication skills. Students experiencing these events can recognize their own personal automatic responses in conflict situations. Discovering these behaviors in a safe learning space, allows participants to become more conscious to their behaviours and responses in similar situations. This awareness is based both on “a clear understanding of the need for change” and exploring additional possibilities for dealing “when faced with similar situations in reality” (Eizenhamer, 2016, para 4). The simulation experience is done in a safe and protected environment. Professional actors provide a real event experience when playing the role. Replaying the recorded video of the simulation enables the students to relive the role providing a space for growth both on a professional and personal-emotional level.

Shapira-Lischinsky's research (2012) shows that the simultaneous process has many advantages: a) An investigation of ethical events without the time pressure that characterizes the work in the field; b) Active guidance leading to the commitment of the participants; c) An experiential training that leaves an impression on the learner, so that the learning content is embedded over time; d) The raising of emotional aspects that participants are sometimes not aware of, which affects the process of decision making in everyday situations and at ethical events and which raise the importance of investigating organizational ethics.

In light of the positive ramifications of the simulation on the teachers' work and in particular the new teachers, the Ministry of Education supported the establishment of simulation centres in the colleges of education in order to promote and foster effective conditions for teaching and learning by integrating relevant communication skills into the routine conduct of teachers and educators. In addition, the program aims to promote the abilities of teachers in the individual dimension of teaching through learning-based simulation experience (Israeli Ministry of Education, n.d.).

This study focusses on the impact of Learning-based Simulation on the professional development of intern teachers through examining their satisfaction with their learning-based simulation experience with an emphasis on developing communication skills, learning about a new teaching method, self-reflection and more. The aim of this study is to develop applicable knowledge in the design of simulation workshops that support the teaching goals and professional development of new teachers, as well as to develop a theoretically informed knowledge base about the contribution of experiential simulative learning to the training of intern teachers.

Simulation workshops

The simulation workshops are held in small and intimate learning groups, in advanced technological simulation studios, enabling the visualization of video simulations. In the simulation workshops, the participants take part in a practical learning experience in a safe space, and participate in simulations of different pre-selected scenarios according to the needs of each group. According to Eizenhamer (2016), “these scenarios are written according to an ‘if-then’ model whereby the actors react dynamically according to the interpersonal interaction created by each individual volunteer in each simulation” (para. 6).

In the simulation workshop, participants take part in the simulations of conflict situations, featuring professional actors who are trained to play roles of people who work in their professional world, such as students, parents, and professional staff. The roles vary according to the conflict and the complexity of case stories and are adapted and/or developed in accordance with the needs of the participants.

According to Eizenhamer (2016, para. 7), “The simulations are recorded on video, which advances a deeper learning experience through the video-based-debriefing process that takes place after each simulation. This debriefing inquiry process allows participants to see themselves in action and to identify additional and new communication skills which can be consciously chosen for use in similar situations in the future”. This is how learning is done through the simulation.

Studies show that learning in the simulation process is done through the role play in the simulation workshops and at the debriefing stage, when participants watch and examine selected pieces taken from the role play in the Simulation (Masats & Dooly, 2011).

After experimenting with the simulation and after the debriefing process there is “a process of feedback” (Israeli Ministry of Education, n.d., para. 3) that includes self-feedback of the participant who played a role in the simulation, feedback from the group, feedback from actors about their interpersonal experiences with the participant and feedback from the group facilitator. In addition, each participant who experiences the simulation receives a copy of the video recorded simulation in which he or she participated in a portable disk for personal use, and written feedback of the workshop participants about the simulation, so that the learning process can be continued even after the workshop. The Israeli Ministry of Education notes that “following participation in a simulation workshop, participants can become better acquainted with themselves and adapt additional ways of coping, beyond the automatic patterns they are used to” (n.d., para. 4).

Study questions

- To what extent do interns perceive participation in simulation as a tool for learning?
- How does the facilitator's intervention contribute to the experience of participation in the simulation?
- To what extent did the scenarios and their analysis by the actors affect the participants' experience in the simulation?
- How do the events used in simulation contribute to participants' ability to deal with their own responses to a conflict situation?
- To what extent does participation in the simulation contribute to the acquisition of communication skills among participants?

Methodology

The present study was carried out in a mixed approach of qualitative and quantitative methodology in order to strengthen the validity of research and enrich the area which it discusses. The qualitative data include structured interviews with intern teachers and observations in the simulation workshops in an attempt to understand the processes taking place in the simulation workshop and to give explanations to the perception of the process by the participants (Sabar, 2006). The quantitative data include a survey of satisfaction from the simulation-based learning method. The quantitative data was collected via an online two-part questionnaire: 1) 18 closed questions; 2) 3 open questions. Responses were measured using a five-point Likert scale with 1= "*completely disagree*" and 5= "*completely agree*". The interns had to respond to the questionnaire after experiencing two simulation workshops.

Sample: The quantitative sample included 130 interns from all specializations: Science Teaching, Arts, Special Education and Early Childhood. The qualitative sample included 10 participants: 2 interns from Special Education; 2 interns from Early Childhood; 3 interns from Arts; and 3 interns from Science Teaching.

The sample was chosen from an Arab college for education in Israel and it is one of convenience (Zamir & Beit-Mariam, 2005). Due to logistical constraints, we chose intern teachers that were available to the researchers at the right time and right place. While this sample is not representative of the entire population, it allows us to obtain basic data and trends regarding the contribution of simulation based-learning method to the professional development of beginning teachers.

Data processing: Quantitative data were processed and analysed by quantitative research methods using descriptive statistics. The empirical material gathered from the interviews was processed into texts and each text was analysed into content units. The content units were categorized and sub-categorized and went through a quantitative process (Ryan &

Bernard, 2000). After the categorical structure was solidified, the findings were surveyed, analysed and discussed.

Findings and Discussion

Quantitative data as well as qualitative data show that all the interns perceive participating in simulations as an effective tool for learning, as shown in Table 1.

Table 1
Effectiveness of Simulation Workshop N (%)

Items scaled	**Don't agree at all (1)**	**Don't agree (2)**	**Hesitant (3)**	**Agree (4)**	**Totally agree (5)**
V1: the discussion in the group before the simulation revealed a new method of learning	1 (.8%)	0	15 (12.3%)	54 (44.3%)	52 (42.6%)
V2: simulation is an effective means of learning	0	0	4 (3.2%)	47 (37.9%)	73 (58.9%)
V6: the active discussion in the group after the simulation has contributed to analyzing the event	0	2 (1.6%)	8 (6.5%)	61 (49.2%)	53 (42.7%)
V11: I have learned a lot from discussing the event with colleagues in the group and the actors	0	3 (2.5%)	12 (9.8%)	56 (45.9%)	51 (41.8%)

Quantitative data show that 87% of the interns totally agree or agree that the discussion in the group before the simulation revealed a new method of learning while 13% are hesitant or do not agree. Almost all participants (97%) totally agree or agree that simulation is an effective means of learning: *"Simulation is an amazing means for learning, I have learned a lot at the first experience, it is a new way of thinking and dealing with cases in classroom, it is very useful"* (It should be noted that here and elsewhere, student testimonials have been translated from the original Arabic by the authors). Eighty-eight percent (88%) have learned a lot from discussing the event with colleagues in the group and the actors, and 92% think that the active discussion in the group after the simulation has contributed to analysing the event: *"I learned a lot from the workshop during the active discussion with actors and classmates. Everyone has a point of view and we benefit from everyone"*.

Studies have already shown that group simulations have the potential to promote learning from two aspects: (a) a better transfer of knowledge (Anderson & Lawton, 2009); and (b) strengthening knowledge retention (Clark, 2007).

The intervention of the facilitator has a significant impact on the level of satisfaction of the participants, as shown in Table 2.

Table 2
Contribution of the Facilitator to the Simulation Workshop N (%)

Items scaled	Don't agree at all (1)	Don't agree (2)	Hesitant (3)	Agree (4)	Totally agree (5)
V3: The facilitator was successful in creating a comfortable and motivating atmosphere among the participants	0	0	6 (4.9%)	49 (39.8%)	68 (55.3%)
V4: The facilitator was successful in attracting participants' attention	0	0	6 (4.8%)	52 (41.9%)	66 (53.2%)
V5: The facilitator was clear in his instructions	0	0	5 (4.0%)	52 (41.9%)	67 (54.4%)

Among the positive things that were noted by participants about the workshop was the workshop's facilitator: *"The performance of the facilitator, her organized work and her professionalism"*. This impact is reflected, as 95% of the participants totally agreed or agreed that the facilitator was successful in creating a comfortable and motivating atmosphere among the participants, in attracting participants' attention, and in her clear directives: "*This was my first experience in simulation and I was sceptical about what lies ahead. But when the facilitator opened the workshop, things looked different. Relaxed and speaking softly, she clarified the aims of the simulation and immediately created a comfortable atmosphere for experiencing and learning"*.

One of the main reasons that teachers abandon the teaching profession is poor training or lack of training in proper preparation for coping with real-time classroom scenarios, in which the beginning teacher is required to be skilled in the management of class and decision-making (Israeli Ministry of Education, n.d.). Simulation aims to help new teachers to integrate theories with actual classroom teaching practices through real-life scenarios in which they take part along with the actors. In this context, 90% of the participants totally agreed or agreed that through the actors' representations they have explored new tools and skills to resolve conflict, and 95% totally agreed or agreed that they have learned from the actors' reaction in analysing the event and that they believe that the actors were able to depict the scenario correctly and truly: *"All the events were interconnected. The way the actors presented was wonderful and encouraged us to speculate about what would happen after each and every event. Everyone was listening and interacting with the actors from beginning to the end"*.

Despite the traditional process of training of teachers, the "real"/"true" world of teaching that is revealed in front of them when they actually teach is considerably different from what is portrayed in their view as preservice teachers and they feel unprepared for actual teaching in front of a classroom. Following is the contribution of the simulation in this context, as an interviewee noted: "*Despite the training I have acquired, I do not feel self-*

confidence in managing conflicts and solving behavioural problems in class. But after I volunteered to take a role in a simulation and after analysing my performance in the scenario by the actor and group, I have been exposed to my weak points and learned how to deal with similar cases in the real classroom. This experience contributed to my self-confidence in class, no doubt".

The simulation workshop constitutes a supportive environment and encourages learning and consideration of different perspectives, as presented in Table 3. Up to 95% of the interns totally agree or agree that through the roleplay of the actors, they have acquired new skills and tools for analysing and synthesizing events, while 92% have learned from the actors' responses how to act in similar situation.

Table 3
Actors Play a Major Effective Role in the Simulation Workshop N (%)

Items scaled	**Don't agree at all (1)**	**Don't agree (2)**	**Hesitant (3)**	**Agree (4)**	**Totally agree (5)**
V8: I have acquired new skills through the roleplay of the actors	1 (.8%)	2 (1.6%)	10 (8.1%)	58 (46.8%)	53 (42.7%)
V9: I have acquired new skills and tools for analyzing and synthesizing the event through the roleplay of the actors	1 (.8%)	0	5 (4.0%)	68 (54.8%)	50 (40.3%)
V10: I have learnt from the actors' responses how to act in similar situation	0	1(.8)	9(7.3)	61(49.6)	52(42.3)

Table 4 shows that around 89% of the interns totally agreed or agreed that the debriefing process that took place after the simulation helped them to review their own responses in the conflict action and to reconsider the reactions of others: "*Watching ourselves enables us to rethink our actions and reactions, returning to events and analysing them together*".

In the same spirit, 82% of the interns totally agreed or agreed that following the simulation, they received positive reactions from the group, and 94% of them enjoyed the learning process through the simulation.

A primary goal in training teaching professionals is to impart to new teacher's effective communication skills to work with students and staff on a daily basis. Therefore, educators may want to consider simulations and other less traditional methods to provide opportunities for their students to learn and practice appropriate communication skills for the field. A summary of intern responses to questions about communication skills is included in Table 5.

Table 4

Contribution of Simulation to Conflict Resolution N (%)

Items scaled	Don't agree at all (1)	Don't agree (2)	Hesitant (3)	Agree (4)	Totally agree (5)
V7: the group feedback was positive	0	1 (.8%)	21 (16.9%)	64 (51.6%)	38 (30.6%)
V12: the debriefing process that took place after the simulation helped me to review my own responses in the conflict action	0	0	14 (11.3%)	55 (44.4%)	55 (44.4%)
V13: I have enjoyed the scientific simulation experience	0	0	7 (5.6%)	52 (41.9%)	65 (52.4%)
V14: the debriefing process that took place after the simulation helped me reconsider the reactions of others	0	0	12 (9.7%)	57 (46%)	55 (44.4%)

Table 5

Contribution of the Simulation to the Acquisition of Communication Skills N (%)

Items scaled	Don't agree at all (1)	Don't agree (2)	Hesitant (3)	Agree (4)	Totally agree (5)
V15: the simulation experience contributed to acquisition of communication skills	0	1 (.8%)	7 (5.7%)	55 (44.7%)	60 (48.8%)
V16: the simulation experience contributed to acquisition of active listening: expressing opinions, asking questions	0	0	6 (4.8%)	58 (46.8%)	60 (48.4%)
V17: the simulation experience contributed to the acquisition of non-verbal communication skills, response and expression of empathy	2(1.6)	2 (1.6%)	14 (11.3%)	56 (45.2%)	50 (40.3%)
V18: the simulation experience contributed to the acquisition of encouragement, respect and collaboration	0	2 (1.6%)	7 (5.6%)	61 (49.2%)	54 (43.5%)

Almost all interns (94%) totally agree or agree that the simulation experience contributed to acquisition of communication skills, especially active listening: expressing opinions, asking questions (95%); encouragement, respect, cooperation and feeling involved (93%). At the same time, 86% totally agree or agree that the simulation experience contributed to the acquisition of non-verbal communication skills, response and expression of empathy; as one of the interviewees said: *“Through my experience in the simulation I have got to know what is active listening, I was encouraged to ask questions and to express my feelings without feeling embarrassed”*. Another interviewee was satisfied to talk about the non-verbal communication skills that she was exposed to and learn: *“This is the first time someone draws my attention to facial expressions, to the tone of the voice, to hand positions and the whole body movements. Oh… yes, non-verbal feedback like a smile and empathic nod or firm face expressions, wow very interesting things happens in the simulation workshops”*.

Simulation has potential as a useful tool for teaching empathetic communication skills. Creating a simulated interview allows students to practice these skills in a realistic setting with consequences tied to their actions (Adcock, Duggan, Nelson, & Nickel, 2006).

Reviews of the effectiveness of simulations show that the majority of studies of simulation environments promote better retention, transfer and a more positive affective response from users (Randel, Morris, Wetzel & Whitehill, 1992). Some suggest these positive results are due to the active participation of users in the environment (Randel et al., 1992). Others feel the ability to create an environment that is interactive, dynamic, and provides feedback through outcomes is the reason simulations work as educational tools (Prensky, 2001). Although there are still questions as to the features that make them effective, the majority of the research shows that simulations provide an opportunity to deliver contextual instruction allowing for experiential learning and deep knowledge (Schweisfurth, 2013, cited in Bovill, 2015). This is expressed by discussing issues with the group and exposing participants to different points of view. The whole process enriches thinking and reveals different ways to analyse events.

The findings of this study are consistent with the literature that promotes simulations as an effective learner-centred training tool that emphasizes the activity of the participants in the role-play and the reflectivity of the viewers using questioning strategies, dialogue among participants, and developing critical and creative thinking skills. This is an interactive and varied learning that justifies the findings of the study by the fact that its ability to influence is sustained over time.

Summary

The present study was carried out in a mixed approach of qualitative and quantitative methodology in order to examine satisfaction of intern teachers with a simulation-based learning method. It presents and discusses participants’ perceptions regarding a simulation workshop’s contribution to the professional development of beginning teachers. The sample included 130 intern teachers who participated in an internship workshop in a college for education in Israel.

The findings show that participants expressed enthusiasm towards the simulation-based learning method and were very satisfied with the simulation workshops in which they participated. They perceive the simulation as an effective learning method that contributes to the acquisition of communication skills and assists in conflict resolution and analysis of classroom scenarios. It contributes to their professional development, and therefore they suggested that they participate in more simulation workshops during their internship process.

In the current era where complexity is increasing, and the educational system undergoes a lack of teachers, simulation based-learning has become a necessary means for enhancing teaching and stimulating qualified personnel to take part in educating the future generations. Such simulations in teacher training will encourage new teachers to learn how to observe, reflect, and analyse ethical events. They will also be able to develop a caring approach that reinforces sensitivity to the thoughts and actions of students, colleagues and principals, and thus be more effective at various events

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IN SEARCH OF ONLINE LEARNING 3.0 IN HIGHER EDUCATION—THE ROLE OF THEORY-BASED PROCESS EVALUATION

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Abstract

In this paper, a model for theory-based process evaluation in online learning is suggested and discussed in relation to its potential as a tool to reveal strengths and weaknesses in a current online module in a fully online course in Educational Science Education. The suggested focal points at this stage of the process evaluation plan are based on socio-cultural outlooks on learning and guided by theory-based process evaluation theory. The evaluation model will be tested for the first time in autumn 2019.

Introduction

In the aftermath of the Bologna Process, expectations of quality in university education in Sweden have increased. At the same time, the shift towards broadened recruitment and mass education has led to increased differences between students' prior knowledge and skills in English and academic writing (Swedish National Agency for Higher Education, 2010 [in Swedish, Högskoleverket]). Accordingly, efforts to assure the quality of university education has been put in place, through national and local evaluations. The mandatory independent work essay stipulated at the national level for the bachelor degree seems to be the stage in education where the educators' ability to realise the expectations from this authority to meet increasingly heterogeneous student groups without adapting the teaching after the students who have the worst pre-knowledge is tested. The Swedish Higher Education Authority (SHEA [In Swedish Universitetskanslersämbetet]), which replaced Swedish National Agency for Higher Education in 2012, explicitly points out the independent work thesis as an important basis for assessing to what degree the students has developed the expected learning outcomes to meet the requirements for each degree. The independent work thus constitutes a basis for the assessment of the results of the education (SHEA, 2018, p. 15). As a result, many resources are spent on supervising students' independent work on the bachelor level, not the least because both the level of throughput and the result from national and local assessments of the quality of these bachelor essays determine the prospect of retaining the power to award a degree as well as resource allocation (Norberg Brorsson & Ekberg, 2012).

But the shifts toward more heterogeneous student groups and higher demands on educational quality are not the only challenges in the university education of today. Over the past 20 years, the proportion of students participating in educational programs conducted online, without any physical meetings, has increased. These students usually constitute even more heterogeneous student groups than on-campus students, for example in aspects such as age and academic background, and often balance additional commitments, such as family and work, alongside their studies (SHEA, 2017).

Online students' interactions with their teachers, fellow students, and the academic environment differ from those of campus students. Students on campus have the opportunity to meet face to face to exchange thoughts and personal interpretations of instructions and expectations of their participation in course activities, whilst online students' communications with peers and teachers often are text based and asynchronous to enable flexible participation. Teachers in campus education are usually present during lectures, laboratory work, and seminars and thus able to immediately answer questions arising during activities, whilst the online students' lectures normally are pre-recorded and, in many cases, watched individually with no interaction with other students, the lecturer, or teachers.

Campus teachers have opportunities to observe the students' performances *in action* to identify to what degree the students' performance reflects that they have understood what knowledge and skills they are expected to demonstrate. This grants the teachers the possibility to interfere in these actions to shape and direct the students' performances - for example to demonstrate "how to do it properly" or by clarifying instructions and provide advice. Teachers in online education usually observe students' performances *after action* due to the course activities' flexible format. This means that the online students could have moved on to other tasks before they are provided extended direction and advice, without any feedback from the previous task to guide them.

Many online students are located in their own home during studies, thus lacking access to some of the informal cues campus students can use to enhance their understanding of the expectations on their performance, for example by "eavesdropping" on conversations between more experienced learners, reading a scientific paper on a wall, and so on. As a consequence, online students may have fewer resources than campus students to guide them to the ideals and expectations within the community of practice that they entered when enrolling in their studies. As we are arguing in this paper, we believe that the nationally identified struggle with students' performance on the bachelor's level could be even more significant in online education without any physical meetings. In this paper, we will present valuable tools to apply during the process to refine current learning designs to help students develop the skills they need to demonstrate when they reach the bachelor level.

In the next section we will describe certain local conditions for online education at the Department of Education in Umeå as a background to the search for tools to enhance our current educational design.

The Case of Educational Science Education at the Department of Education in Umeå University

The department of Education in Umeå has been teaching online and distance students for more than twenty years. Over time the original basic usage of ICT has developed from simply providing information to becoming a virtual classroom in which much effort is put into the design to enhance the students learning experience. Today the majority of the staff enrolled in fully online education, ranging from basic to master level in Educational Science Education (as shown in Table 1), have many years' experience of teaching, researching, and creating educational designs, which means that many of us can be considered to be far on the way towards solid pedagogical digital competence (PDC), as defined by From (2017, p. 48):

> The concept of pedagogical digital competence refers to the ability to consistently apply the attitudes, knowledge and skills required to plan and conduct, and to evaluate and revise on an ongoing basis, ICT-supported teaching, based on theory, current research and proven experience with a view to supporting students' learning in the best possible way.

Our educational design and the instructions for the courses that precede the bachelor's level are usually collectively produced, based on theory and research on online education, and aimed to enhance online students' similar experience of teaching, social and cognitive presence as students on campus perceive. All courses from basic to master level are divided into modules and many of them include tasks designed to train students in academic writing and other skills of relevance for scientific work. Although the training is incorporated in all course work, special aspects of academic writing is highlighted in some modules through theory and training, as shown in Table 1 below.

Table 1.
Overview of Educational Science Education at the Department of Education, Umeå University, courses A-C

Course	Module Name	Core Content	Highlighted Academic Skills
Educational Science Education A	Introduction to Educational Science	History of educational science, areas of research	Academic writing (APA)
	Learning and Teaching	Learning and teaching in the light of theory and research	Reflection Education planning
	Human and Society	Social theories that form the basis of educational research	Theory driven analysis Identify, collect and value scientific publications
	Upbringing and Socialisation	Upbringing in historical and social perspectives	Qualitative interview in theory and practise
Educational Science Education B	Research Processes and Methods	Introduction to scientific work Qualitative and quantitative theory	Formulate and motivate research problems of relevance for Educational Science Qualitative and quantitative data analysis
	Learning and ICT	Theories and research on learning with ICT	Peer review
	Normalisation Processes in Education Practices	Theory and research on how the view on normality is constructed	Oral presentation Ethics
	Independent Work (on basic level)	Plan, conduct and report a pilot study in Educational science	Academic writing Constructing instruments for data collection and analysis
Educational Science Education C	Research Processes and Methods in Educational science II	Scientific theories, methods and ethical considerations	Formulate and motivate educational research problems Quantitative and qualitative data analysis
	Bachelor Essay	Planning, conducting and a reporting a study of relevance to the Educational science research field	

The online students' answers in the questionnaires provided at the end of each module, in which they are asked about how they have perceived the education, indicate that they generally perceive the course design as a sufficient support for their learning, including aspects such as their interaction with peers and teachers. The online students' learning and progress is also in general perceived as satisfactory by the teachers. This indicates that we seem to provide a sufficient learning environment with a good potential to enhance our students' development of expected knowledge and skills. However, as the online students enter the bachelor essay module, similar flaws in skills in academic writing as recognised in campus education (Norberg, Brorsson & Ekberg, 2012) surface and may be more severe in settings like our Educational Science Education which is provided completely online with no physical meetings. These flaws in students' understanding and academic skills are already visible in the last module in Educational Science B, "Independent work" (on basic level). The content and design of the module "Independent work" are meant to support that the students "tie the bag" of knowledge and skills achieved from previous modules. This is supported by activities targeting planning, conducting, and reporting of individual pilot studies in which every step is processed in group seminars and feedback from the teacher.

However, the teachers tutoring online students during the module Bachelor Essay perceive that several of these students still need much supervision. There are always some students with great difficulty producing an essay of sufficient quality in order to be assessed as approved. We also find that some students struggling with the essay work will drop out, never to return, as the throughput of the students enrolled in the Bachelor Essay module usually is between 50-82 percent. This indicates that some students on this level, despite that their demonstration of knowledge and skills during previous modules has been recognised as satisfactory by both themselves and their teachers, have not fully understood what qualities their essay work is expected to reflect.

As we strive to increase the throughput and upgrade a seemingly well-functioning online course design (2.0) to an excellent design (3.0), we found it necessary to investigate the discrepancy between the perceived quality of archived skills and the students struggles during the work with their independent work on the Bachelor level. We also belong to a department which focuses on processes through which man is formed and changed in different social, cultural and historical contexts (Department of Education at Umeå University, 2018). This scientific interest directed our curiosity towards the aim to generate an in-depth understanding of what learning processes the current arrangements in Educational Science Education support, and what they do not support.

In our search for strategies to answer our questions about what changes we should make to strengthen our educational design we reconnected with the theoretical tradition at our department, in which theory-based process evaluation is found to be a vital instrument to refine educational practice. As Franke Wikberg (1990) expresses, it is necessary to have an awareness of the essence of evaluation as a starting point of evaluation and further development of existing local educational practice. This includes the recognition that the quality of educational practice cannot be understood by simple measurements of outcomes. We have adopted this outlook and have employed the principles suggested by Franke Wikberg as we have sketched on our own model of theory-based process evaluation, in which we are combining evaluation theory with sociocultural outlooks on learning. In the next section we will provide the tools we have derived from these theoretical traditions.

Theoretical Underpinnings

In the wide spread "Umeå-modellen" developed by Franke Wikberg (1990, pp. 14-15) ten principles for theory-based process evaluation are central. These principles are [our translation]: a holistic perspective, a focus on explanation, an acknowledgement of the social context, a local development, self-evaluations, local support for development, exchanges of experiences between peers, an "open door" policy, visible values and declared outlooks (including theoretical) and most importantly, the awareness of the essence of evaluation.

In this paper we have tried to describe the context in which Educational Science Education is provided and we have applied a focus on local development. The model suggested in this paper, as our first draft to outline what to target in our self-evaluation, makes it necessary to apply the principle of visible values and declared outlooks, which we are putting forward through the description below. The theoretical origin goes back some decades and is based on the notion of the situated nature of knowledge and learning as constructs, produced and distributed within a 'community of practices' (e.g. family, workplace, school) through constant negotiations on meaning during community activities (Brown, Collins, & Dugid, 1989; Rogoff, 1990; Lave & Wenger, 1991; Wertsch 1991; Rogoff, 1993; Säljö, 2014).

Wenger (2004) suggests that a community of practise is not just a personal network; it is about a domain, an area of knowledge and ideals that brings people together and shapes the group's identity and defines the key issues that members address. The community is the group of people for whom the domain is relevant, and what the members in the community do together, and the tools they share, is what Wenger labels as the practice. Each community has its own purpose, traditions, and ideals. Usually, some members are more experienced than others. This means that newcomers (for example students) will be guided to these ideals and traditions through directions, the response to their own ideas, and by observing more experienced members' actions during community activities, and will start to appropriate ideals and how to use the communal tools (intellectual and physical) in the community activities.

The widespread outlook on learning offered by sociocultural theory often underpins course designs in the context of online learning. Research with this outlook has identified the importance of enforcing online students' notion of cognitive presence (Rourke, Anderson, Garrison, & Archer, 2001) so that the participants can construct meaning through sustained communication, social presence (in which the teacher and participants come across as 'real persons" (e.g. Oyarzun, Barreto, & Conklin, 2018), and teaching presence ("design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes through enforcing collaboration and mediating actions", Garrison & Arbaugh, 2007, p.163).

In the context of education, the teacher could be regarded as an experienced member of the community of practice within the department responsible for the course the online students participate in. Thus, the teacher is in a crucial position to mediate the ideals cherished within the particular community. The teacher's role is to shape and direct the students' performances in line with the ideals of the local community and the nationally stipulated expected learning outcomes. Expectations on performance can sometimes be rather multi-dimensional, and therefore make it difficult for beginners to understand what actions to take to solve a task on their own. The term "scaffolding" is often used to describe the teacher's function as a more experienced community member that assists learners to succeed at difficult tasks. Sadler (2007) describes scaffolding in these terms:

> Properly understood, it means providing appropriate supports during learning so that learners are better able to bridge the gap between what they bring to the learning task, and where they need to be to achieve a deep level of learning. (p.390)

Since learners and teachers are not physically present in online learning, the online environment must be designed to enforce these processes and embedded with functions to scaffold learners' self-regulation skills so they can remain engaged despite the lack of the physical presence of others (Delen, Leiw, & Wilson, 2014). Accordingly, our design for online learning includes activities like online seminars, recorded lectures, forums in which students are interacting with each other and/or their teachers, student generated video presentations, tasks and instructions to stimulate peer discussions and plenty of formative feedback to direct and scaffold learning. However, as put forward in this paper, there are some indications that the current learning design might need adjustment, despite the fact that it is a collaborated product by experienced teachers and research in the field of online learning. This calls for a deeper investigation of strengths and weaknesses in the current design for online learning if we want to move from "good enough" teaching to an excellent level.

Deciding What to Evaluate

In this section, we will describe and discuss our recommendations of aspects to target in a theory-based evaluation based on sociocultural theory of learning design.

National and Local Ideals

If the students enrolled in courses in educational science are regarded as new members of a community, formed with a certain purpose and engaged in activities underpinned by community ideals, it is important to begin the evaluation by understanding what these ideals are about. But educational activities at a university cannot be regarded as only a matter for the course-giving institutions as all educational activities must follow national directions and will have to pass the national evaluations. This means that it is of value to derive ideals from national documents and descriptions of Educational science, the descriptions of this discipline at the local department, and the values mediated through the formulations in course curricula and expected learning outcomes.

Students' Prerequisites

Since the students have participated in communal learning activities throughout previous modules in Educational Science A and B, they are expected to have appropriated some of the ideals and the expected ways to use valued tools in Educational Science and academic writing. It seems fruitful to investigate to what degree such outcomes of previous modules are visible during their participation in early activities of this last module, to shed light on a potential lack of guidance in previous modules, as well as what to focus on in "Independent work" to close potential gaps. It is also valuable to collect information from the supervisors of the bachelor essay to complete the picture.

Scaffolding Potential in Design, Instructions and During Course Activities

Drawing on how scaffolding can fill a function in shaping and directing students' learning and actions to reflect the ideals within the community of practice, we also find it valuable to review what the overall design and structure of the module and the activities could provide in terms of a reflection of ideals. Instructions and teachers' feedback on tasks are also intentionally created, thus underpinned with ideals and expectations of students' performance; it would be worthwhile to scrutinize documents to investigate to what degree the formulations have the potential to mediate such ideals.

During the whole evaluation process, the scrutinizing of these aspects must be in relation to the identified ideals, thus stimulating a process in which the results of the evaluation are useful to guide the re-design process.

Discussion

We believe that an evaluation of conditions in the last module would be valuable not only for the re-design of this particular module, but also to generate a greater understanding of what possible changes need to be implemented in the previous modules, A and B. By putting the suggested evaluation in practice during autumn 2019, we also hope to be able to identify whether we have the functional theoretical resources to understand in what ways we can maximise the students' learning, thus aspiring to develop online learning 3.0.

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MULTIMODAL CARTOGRAPHIC MAPPING: ECOPEDAGOGICAL SPACES IN THE EVOLVING AUSTRALIAN TECH ENVIRONMENT

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Abstract

This paper describes the design and implementation of a project that involved embodied outdoor experiences for mapping Country using ICT. The project was undertaken by preservice teachers learning about the Geography substrand within the Humanities and Social Sciences Australian curriculum as part of the Bachelor of Education, Primary - Aboriginal and Torres Strait Islander Education Program. Results indicate that immersive learning experiences can be embedded authentically with technology to collect and present data. Findings also suggest that pre-teachers can benefit from outdoor experiences utilizing ICT to develop their understanding of symbiotic relationships between technology and immersion pedagogies in teaching practices.

Background

In the Australian context, a recently released national curriculum points teachers towards a futures-focused learning environment for their students. This direction includes an underpinning of general capabilities across the curriculum and provides teachers with ideas about where the general capabilities can be addressed when teaching subject content (ACARA, 2019a). The prominence of the general capabilities has also transferred into school reporting which further indicates the importance attributed to this aspect of the curriculum (Toon, 2017). The focus on the general capabilities has also resulted in the release of national literacy and numeracy learning progressions which guide teachers in differentiating their teaching and learning to meet the individual needs of students from Foundation to Year Ten. A strong focus on supporting the implementation of technologies also continues, with the address of ICT through two arms: ‘Design and Technologies’ and ‘Digital Technologies’. This is evidenced by a recent initiative of the Australian Curriculum and Reporting Authority (ACARA) on supporting the implementation of digital technologies through a National Innovation and Science Agenda (NISA).

The project reported here focused on the Humanities and Social Science curriculum (HASS) for two overarching reasons. The first being that the inclusion of the Geography substrand within the Humanities and Social Science curriculum is relatively new for Australian primary schools. It is vital for preservice teachers to learn about the geographic content knowledge and geographic processes of inquiry, particularly with the likelihood of entering schools that have been operating with this new curriculum for limited time. And secondly, the project sought to develop preservice teachers' knowledge about authentic ways to implement place-based outdoor education in an evolving technological world. It thus contributes to new knowledge about ways to implement digital technologies when teaching the Geography sub-strand of the Humanities and Social Sciences primary curriculum.

Embedding immersive experiences utilizing transformative practices is also a significant point to address with growing concerns that children are increasingly alienated from nature and devoid of outdoor experiences (Charles, 2018; Sobel 2004). This phenomenon is argued to be growing despite research which identifies the benefits of personal lived experiences in the outdoors for building up nature-human connections (Bates, 2018a; Charles, 2018; Chawla, 2007; Gray & Birrell, 2015; Malone, 2016; Louv, 2011). As such, the project focused on weaving eco-pedagogies with ICT capabilities because it involved an outdoor place-based immersion and utilized technology applications as transparent operators for collecting, representing and sharing data collected in the field (Hunter, 2015; Mishra & Kohler, 2012).

As educators know, learning requires the intertwining of many kinds of capabilities in this new intersemiotic space. We need to equip students with the necessary skills to navigate how data is collected, represented and shared. To this end, the project sought to incorporate opportunities to develop and apply ICT skills for thriving in an increasingly digitized world while building nature-human connections in concrete ways.

Targets and Specifications

The project targeted the development of the Humanities and Social Sciences curriculum content knowledge, pedagogical knowledge and ICT capabilities with preservice teachers. A particularly distinctive aspect of the project involved a group of Aboriginal Peoples in the Bachelor of Education (Primary) – Aboriginal and Torres Strait Islander Education course. The students were actively involved in reflecting on their connection to Country and considering the implementation of a similar project with Indigenous and non-Indigenous primary school children in their future teaching practice.

The Equipment and Software

The cohort of 15 preservice teachers utilized their own mobile phone devices with photographic and recording capabilities during their data collection stage. Preparation also required them to download 'Cardboard Camera' onto their mobile device and ensure they had set up a Google account to use 'Google My Maps' as one tool for representing their work.

Photos collected using Cardboard Camera were shared in a public learning space using Virtual Reality Goggles, which were provided by the facilitator in the last stage of the project on the university site. The last two stages were also supported by the application of 'Piktochart', which preservice teachers used to present their unit outline about 'place' in alignment with the Humanities and Social Sciences curriculum outcomes.

Training Preservice Teachers

Preservice teachers were provided with a thirty-minute training session which involved them in learning how to sync their mobile devices and practice using Virtual Reality Goggles. They participated in a joint construction of a Google MyMap during a two-hour workshop prior to utilizing this ICT tool independently and were offered one-to-one support during the creation of their 'Piktochart'.

Description of the Project

Definitions

Prior to describing the project there are a number of key terms used in describing the project that require definition.

Australian Professional Standards for Teachers are required to be met by teachers in ordered to maintain teacher registration in Australia. They are public statements of what constitutes teacher quality and required to be fulfilled as part of the Australian Teacher Accreditation process (AITSL, 2019).

Country is used in this context as an acknowledgement of the First Nations Peoples and their continuous connection as Sovereign people of the land we now call Australia. It is capitalized in all points of use.

Ecopedagogical Approach involves educational moves which create opportunities for humans to make conscious connections with the natural world through ecological ways of experiencing, thinking and knowing.

General Capabilities are addressed through the content areas of the Australian Curriculum. They aim to address specific skills, knowledge, behaviours and dispositions that equip students in their lives in and out of school (ACARA, 2019).

Intersemiotic Space refers to the representation of meaning using two or more communication codes or sign systems. In this project, the preservice teachers interweave oral and written linguistics, still and moving images, and sound to produce their portfolios. Intersemiotic work also encompasses the use of multiple modes to represent meaning. In this project, the groups used digital and paper modes to represent meaning.

Phenomenological Approach focuses on the way that the world is experienced by the people who live in it. It focuses on what individuals attend to, take in, interpret from their experiences, and deem as meaningful.

Reflective Practitioner in this context involves the participant in reflecting on praxis as an individual and their interaction with collective participants in the practice of teaching.

Storylines is a term that can be used to describe stories told by Aboriginal people.

The Project's Approach

From a phenomenological viewpoint, the project involved preservice teachers authentically in articulating aspects within Geography strand of the Humanities and Social Sciences by researching a personal place of significance. Designed to be participatory, the exploration of curriculum was intended to develop preservice teachers' understanding that the study of place needs to be operational and active rather than a perceived or abstract one restricted by classroom walls (Bates, 2018a; Barford & Bensen, 2018; Gray & Birrell, 2015; Gendlin, 2004).

From an andragogic viewpoint, the project centred around the nature of building preservice teachers' professional knowledge, in particular how this knowledge was construed and constructed. As an imperative, the approach supported the group in using their inquiry experience to inform their teaching using a shared language to talk about their practice (Bates, 2018b; Campbell, 2011; Groundwater-Smith & Mockler, 2015).

Embedding the project with the Tertiary Course Learning Outcomes

Focused on their future work as primary school teachers, and as adult learners, the project formed part of the preservice teachers' first assessment task and supported the following course outcomes for Graduates of the Bachelor of Education (Primary) – Aboriginal and Torres Strait Islander Education course.

- Demonstrate critical knowledge and understanding of disciplinary content, pedagogical, and technological knowledge, and the relationship between educational theory and practice.
- Reflect on practice and apply appropriate pedagogies and technologies that enhance the learning development of students' diverse needs, including social, cultural, academic, emotional and physical needs.

The project also aligned with the three of the six categories from the Australian Professional Standards for Teachers in order to develop the necessary skills all teachers need to develop and to maintain accreditation for working in Australian schools:

Standard One: Know students and how they learn

- Explain the role and value of Geography in the broader school curriculum and the relationships with literacy and technology general capabilities.

Standard Two: Know the content and how to teach it

- Apply knowledge of the disciplines, theories and pedagogies that underpin the learning area to learning design.

Standard Six: Engage in professional learning

- Present a personal exploration of the local area, using historical and geographical artefacts and apply the research project to related curriculum content.

The Project Sequence

The project involved six stages and various elements within each stage (Figure 1).

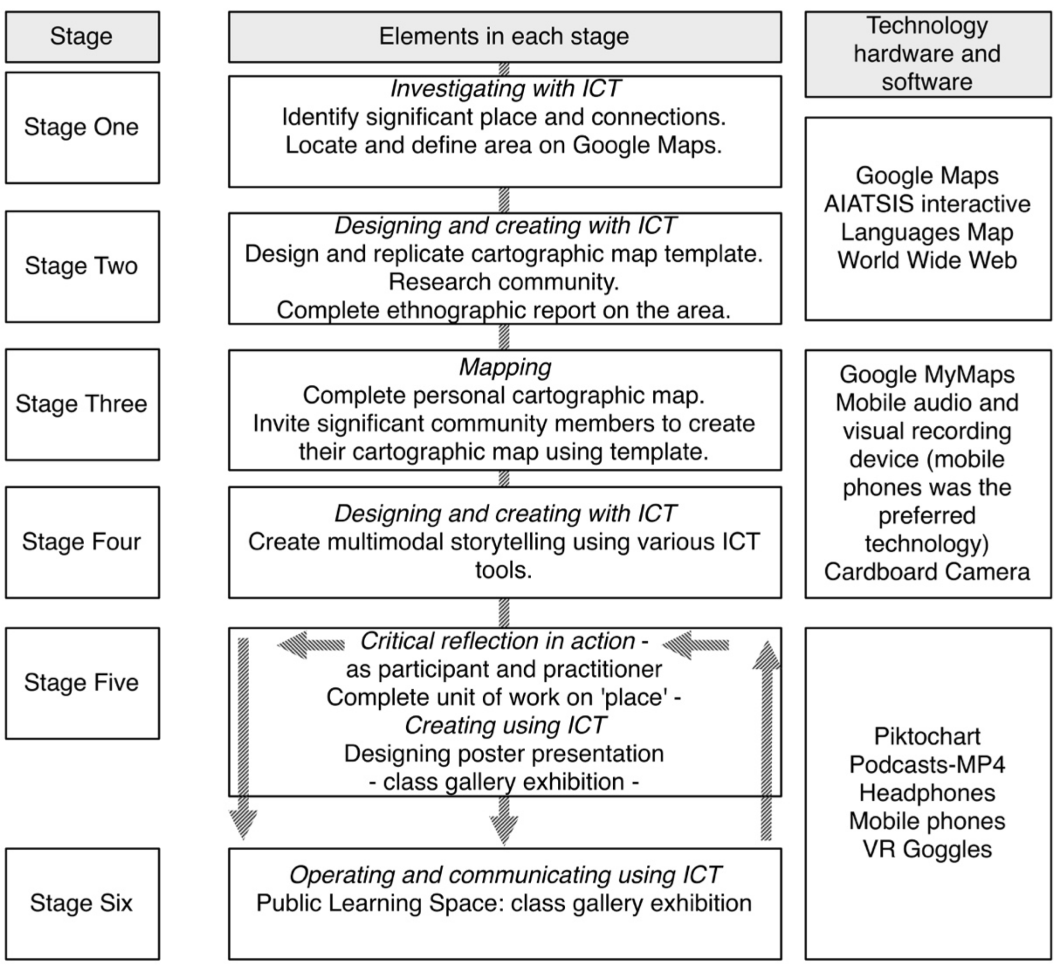

Figure 1: The project flowchart

Stage One: Investigating with ICT

The first stage involved the group of preservice teachers in selecting a significant place from their community that was special to them. Each preservice teacher was then involved in researching their significant ‘place’. They gathered information from historical societies, library archives, the local community, civics action groups, census data and other relevant bodies to inform the content of a written ethnographic report about their chosen place.

Stage Two: Designing and creating with ICT

The next stage involved each preservice teacher in the design and creation of a cartographic map in the role of map-maker. This stage engaged them with geographical inquiry skills from the Humanities and Social Sciences curriculum (ACARA, 2019). The cartographic maps were initiated by identifying boundaries using Google Maps. Using the digital map, a line drawing using the identified boundaries was created. This formed a template which was then replicated on art paper to create a set of map templates for distribution to other participants during the next stage of the project.

A number of complexities arose during this stage because as map makers they had to decide on the delineations of their map boundaries. These decisions centred around whether their map would be delineated by pre- or post-contact boundaries, language, or cultural groups (dominant or minor). The interactive Australian Institute of Aboriginal and Torres Strait Islander Studies language map (AIATSIS, 2019) created much discussion and highlighted the significant loss of original first language on this continent. Despite this interest, no pre-service teacher utilized the language maps to delineate their boundaries.

Stage Three: Mapping

Each participant then used the map template they had created to complete an artistic representation of what was important to them about the place they shared and how they were connected to their significant place. After they created their own map, they invited people from their community to undertake the same map making process using the template they had designed. One of the cartographic maps that was produced is illustrated in Figure 2.

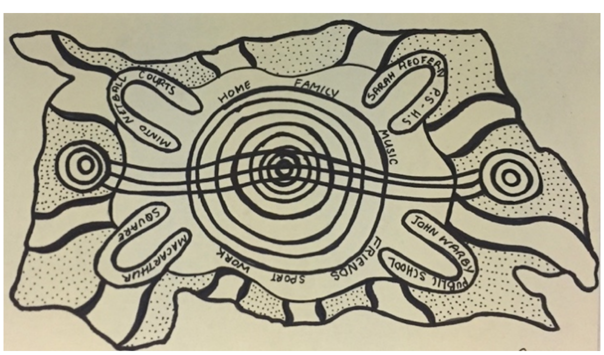

Figure 2. Donna’s cartographic map

Stage Four: Creating and designing with ICT

At the core of the project was the intent of providing platforms for creating multimodal storylines using ICT. As such, the preservice teachers were also involved in collecting multiple artefacts to be part of their digitized storyline. The photographic artefacts collected using Cardboard Camera were added to their Google MyMap. Labelled layers were added on these digital maps to locate places and activities that were important to them. These were accompanied by linguistic recounts, descriptions or poems (Figure 3). A personal podcast was also created during this stage and shared during stage six of the project.

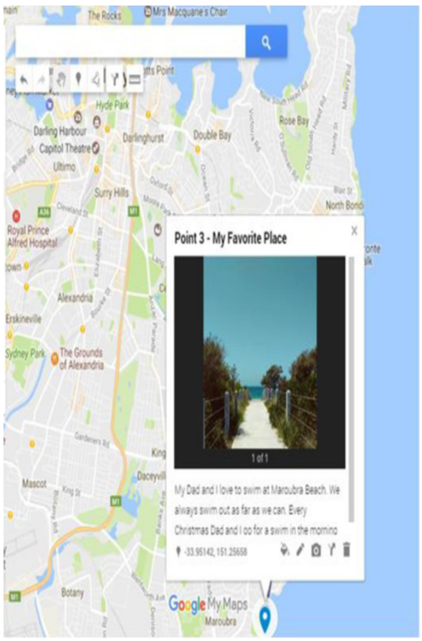

Figure 3. Utilizing Google MyMaps

Stage Five: Creating using ICT

The reflexive inquiry approach focused this stage of the project. It involved preservice teachers in discussing and reflecting on the challenges and opportunities they experienced in the role of practitioner during the data collection and creation stages.

The Humanities and Social Sciences curriculum outcomes were then drawn on to guide a discussion about potential challenges that primary students might experience when undertaking a similar project in the primary classroom. Post this discussion, each person designed a unit of work that aligned with the Humanities and Social Sciences curriculum. Participants were required to represent their ideas on a poster using the Piktochart application.

Stage Six

This final stage provided an essential step in sharing constructed knowledge in a public learning space (Hunter, 2015). The exhibition engaged the group in sharing their portfolios set up as a gallery exhibition. Photographs that were collected using cardboard camera in stage two were synced to virtual reality goggles and shared amongst the group. Sets of headphones were set up where personal podcasts were listened to as individuals viewed using VR goggles. At the end of the exhibition, the preservice teachers were asked to reflect on the process.

Looking back on the project

Opportunities

The project demonstrated how to apply rigorous and engaging learning that connects with the underpinnings of the Australian curriculum. In particular, it addressed authentic ways for incorporating the General Capabilities in content learning when designing learning tasks. As such, the task design purposefully incorporated five of the seven General Capabilities (ACARA, 2019a) being:

- Literacy – writing personal reflections and informative texts
- Numeracy – reading and composing maps
- Information and Communication Technology (ICT) Capability – process of researching and product creation
- Intercultural Understanding – making connections with their world and the world of others
- Critical and Creative Thinking – applying thinking skills for inquiry, interpreting, analysing, sequencing content and in appraising tools, tasks, processes and performance. Applying skills in scaffolding this type of learning for students in primary school.

The second dimension centred around the Australian curriculum's commitment to designing personalized learning programs in order to cater for student diversity. The learning task provisioned preservice teachers with choice, various modes and degrees of scaffolding to support their learning needs. The choices around the design of cartographic maps resulted in the representation of various geographical urban, rural and remote regions in various visual designs thus replicating aspects for addressing student diversity in the primary school setting (ACARA, 2019c).

The task also specifically engaged preservice teachers in learning about the curriculum content. Investigations that ensure students develop "a sense of wonder, curiosity and respect about places, people, cultures and systems" are a mandatory part of studying the Humanities and Social Sciences in the Australian curriculum (ACARA, 2019b). This project successfully demonstrated an opportunity to enact factual informative texts about place utilizing ICT to inform teaching the Humanities and Social Sciences. Moreover, this project offered more than the opportunity to explore the historical and geographical aspects of place involving population data, employment statistics, latitude or longitude marks on cartographic and Google maps. Interpersonal connections with place were significant with preservice teachers utilizing personified language to infer concepts of Country as "mother, nurturer, teacher and protector." Commentary by preservice teachers looking back at the assignment task also indicated that the assignment assisted them in developing their understanding of the place they grew up in (Personal communication, December, 2017).

Interpersonal relations were also demonstrated between preservice teachers through high levels of social interaction, empathy and collaboration in the development, setting up of 'Pictochart' displays and when listening to each other's podcasts. The presentations demonstrated that place connections were distinctly personal and 'place' was described by one preservice teacher as holding "a great power…providing strength physically and mentally (Student response, December, 2017)." These results demonstrate the interpersonal value of incorporating place-based inquiries in contemporary teaching and learning practices.

Finally, I purposefully designed the project to include explicit models, participatory experiences, responsive constructivist learning as students designed their maps together and reflected on their experience. These aspects were included with the desire to inspire preservice teachers to actualize this pedagogy and build their capacity to be responsive and successful future practitioners.

Challenges and limitations

The project with 15 preservice teachers offered many opportunities for participatory and reflective practice. However, I experienced an unexpected challenge when implementing this project. The challenge centred around my presumption of a collective high-level tech 'savviness' amongst the group. Despite research arguing that text savvy millennials are shaping tertiary education (McHaney, 2011), a number of preservice teachers in this group were challenged by the more academic use of technology applications that stretched them beyond their 'social media' scope. This impacted on the degree of tenacity for experimenting with technology applications, the time required to practice the ICT tools, the end results involving technology and, the confidence in sharing their maps as a public display.

The Evolving Tech Space Across the Curriculum: Through, in and out of the Classroom

From an educational premise, embodied experiences in the outdoors are critical to foster because they nurture a bond between the human and more than human world (Gray & Birrell, 2015; Sobel, 2004). A relationship edifice of this type not only incorporates current ecopedagogical approaches for investigating local place but is critical in these unprecedented times where the world finds itself faced with precarious environmental issues. It is one that can be supported by engaging students in collecting, designing and operating with ICT in outdoor spaces for working in the Humanities and Social Science curriculum.

Educational moves which create opportunities for connecting with the natural world must also involve key elements to ensure teaching practices are future-focused. I therefore argue that teaching and learning about the world must be underpinned by approaches that are contemporary relevant, creative, active and interactive but also ecopedagogically robust, culturally sensitive and ethical (Groundwater-Smith & Mockler, 2015; Hunter, 2015; McKnight, 2016; Moore & Cooper-Marcus, 2008). Cartographic mapping projects are examples for encouraging these types of approaches to ensure students' learning experiences are in-depth, with-nature and on-point. Moreover, creating early connections in the locale with students, builds stronger foundations towards their broader understanding of community, national and global environmental perspectives (Bates, 2018b; Grienswald, 2003; Hung, 2014).

Furthermore, this project also demonstrated that authentic technology integration can accompany a participatory ecopedagogical approach in schools. It is immersive and metacognitive rather than being a mere abstract propagation of nature through a virtualized world (Bateman, 2015; Bates, 2018b). It shows one way to bridge the growing divide between outdoor immersive experiences and the growing indoor technological and media-based recreational pursuits (Bates, 2018a; Andrejewski, Mowen & Kerstetter, 2011).

Teachers of Tomorrow: Place-based Pedagogies in a Technological World

Central to the effectiveness of embedding transformative technologies in the learning is the role of the teacher (Brady & Kennedy, 2019; Hattie, 2018). As a critical factor in students' learning, teachers are not conduits to using devices but channels for ensuring technology is applied authentically to capture different modes of learning, ways of knowing and creative productions of knowledge (Hunter, 2015). These types of designed learning experiences not only offer opportunities to build preservice teachers' pedagogical knowledge and capacity but their confidence to use technology in transformative ways for their future work in schools.

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EVALUATION OF AN E-LEARNING COURSE IN MOODLE IN COMPARISON TO A TRADITIONAL LESSON

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Abstract

A Moodle course was used in an e-learning unit to compare undergraduate students' outcomes to those in a traditional lesson. A traditional teaching unit was presented for a parallel control group. After the lessons, the students performed the same exercises. Afterwards, the learning success of the students was compared. In addition to the quiz assessment, the students were asked about their personal impressions in a questionnaire.

The result of the quiz was that the group with the traditional lesson achieved results that were slightly better than those of the e-learning group. The evaluation revealed that the students' opinions about the e-learning course differ more than the opinions about the traditional unit.

Keywords: E-Learning, Motivation, Evaluation, Comparison, Moodle Course, Knowledge Management, Knowledge Modeling and Description Language

1. Motivation and Project Background

Sponsored by the STAEDTLER Foundation, a project to support underrepresented groups in STEM (Science, Technology, Engineering and Math) subjects is being carried out at the Department of Computer Science at the Technical University of Nuremberg Georg Simon Ohm (TU GSO). The project includes "people from non-academic families, those who come from a migrant background and women have been underrepresented in STEM subjects at universities" (Schötteler & Brockmann, 2019, p. 3100). This project intends to counteract the shortage of specialists in the STEM occupations by supporting underrepresented student groups (i.e., students with a migration background, from non-academic households, female students) before, during and after their studies. To this end, digitization measures in STEM studies should be evaluated and carried out at the TU GSO Nuremberg. The entire life cycle plays a decisive role, starting with the choice of the students' course of study, through university or college study to entry into the labor market, and is included in this research project. Specific digital prototypes will be developed as supporting measures. One question within this project is: Can e-learning be a useful instrument to explain complex topics? Self-reliantly learning with electronic media is an essential qualification for students' future working-life (Schuhbauer, 2018, p.

2724). Maybe e-learning has an additional value, especially for students who cannot attend the lessons. It allows them to repeat the units. This may be necessary for students who have to work or to take care of children or elderly or handicapped persons. E-learning supports repeating the material and preparing for tests.

In this paper, first the advantages and disadvantages of e-learning are described briefly. Afterwards, the research field is specified. Then the characterization of the traditional unit and the e-learning unit that were developed for this project follows. The test and the evaluation after the units are described in sections six and seven. The paper ends with a perspective on future work.

2. Advantages and Disadvantages of E-Learning

In this paper, I define e-learning as the support of teaching and learning processes through digital media or tools. The most common advantages of e-learning are the independence from time and place, the unlimited number of participating students, the ability to repeat the lesson, standardized contents and the possibility to offer different media. On the other hand, e-learning demands self-discipline of the students; it offers fewer possibilities to ask personal questions; and the teacher does not get feedback from the students. Working on a computer screen can be tiring. Some related works point out the advantages and disadvantages of e-learning (Radovic-Marcovic, 2010; Arkorful & Abaidoo, 2015).

Rivera and McAlister (2001) worked out a similar research study. They randomly divided students of the course "Management Information Systems" into three groups. Forty-one students received a traditional lecture. Forty students were divided into a hybrid section in which the course was also held as a lecture. In addition, course materials were made available online and included in the course. For the third group of fifty-three students, the course was largely only offered on the web. Subsequent examinations did not reveal any significant differences in the performance of the participants in the three groups. In contrast, in a survey of student satisfaction, there were differences. The web-based course scored particularly poorly, regardless of the same performance of the students in the test. The low level of satisfaction was associated with problems in providing the online platform and course materials. Overall, it was noted that concerns about the use of e-learning courses were more related to student satisfaction than to learning success. However, this study is more than eighteen years old. This could be a clue that the results found are no longer valid today.

Dondorf, Breuer & Nacken (2016) carried out a similar comparison. The traditional student group achieved significantly better performance results than the e-learning group. The satisfaction of the e-learning course was also surveyed. Three quarters of the students believed that they had learned more in a traditional course. Motivation is cited as an important factor for the poorer performance of the e-learning group.

The WICHE Cooperative for Educational Technologies (WCET) lists some studies at their website "no significant difference" (WCET, 2019) which compares the students' outcomes using alternate modes of education delivery. In addition to these studies, the aim of our project is to find out the usability of e-learning especially for complex topics.

3. Research Field

The subject "knowledge management" is part of the bachelor's program in information systems during the 4th semester. Students should learn the contents of knowledge management. They should understand the requirements of knowledge management in companies. At the end, they should be able to design solutions for knowledge management. They should be able to think, to analyze, to classify problems, and to identify solutions of knowledge management.

Knowledge Modeling and Description Language (KMDL) is a complex topic in this field. KMDL describes knowledge flows and conversions "along and between business processes. The KMDL enables the formalization of knowledge intensive processes with a focus on certain knowledge-specific characteristics" (Gronau, 2012, p. 1). This description language for knowledge-intensive processes contains three levels. The students should know the description symbols for each level. They should be able to read and interpret process descriptions at all levels. They should be able to model small processes themselves.

In the summer semester of 2019, one comparison group attended a traditional teaching unit about KMDL; a second group took an e-learning course about the subject. The e-learning course was not designed an asynchronous, online course. The students were progressing through the material in a self-paced manner in a classroom environment, with the instructor present. The participants of both groups attended the course Knowledge Management in the summer semester of 2019 and had a comparable level of pre-existing knowledge. Figure 1 shows the process of the study.

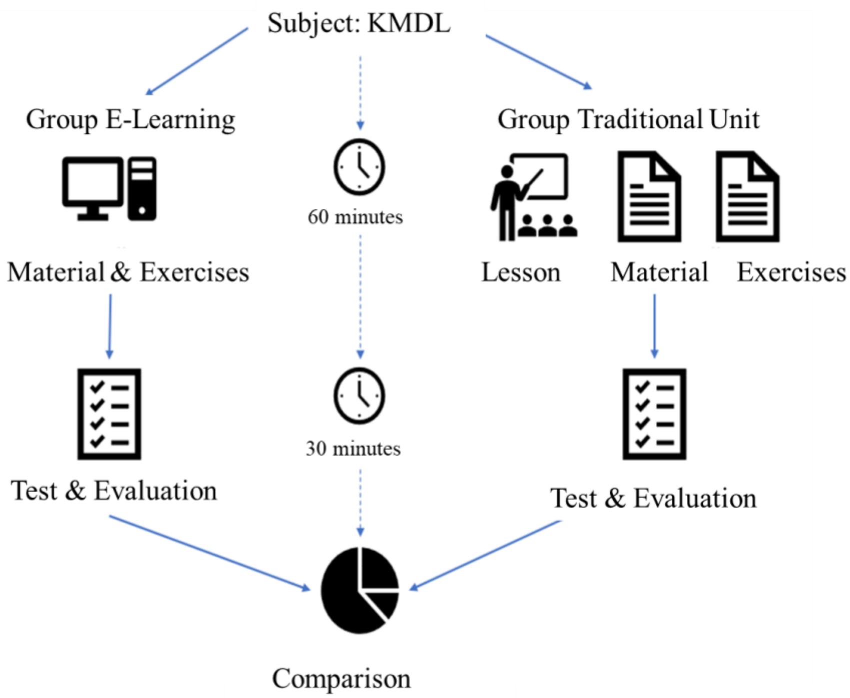

Figure 1. Process of the study.

4. The Traditional Unit

The traditional unit consists of a lesson and exercises. This in-class unit was about sixty minutes. The second group had also sixty minutes for their e-learning course. First, twenty participants listened to a presentation about KMDL. This teaching unit consists of a complete lesson about all three of the KMDL description levels. An instructor explained visuals. Figure 2 shows a slide of this presentation. The students had the chance to ask comprehension questions.

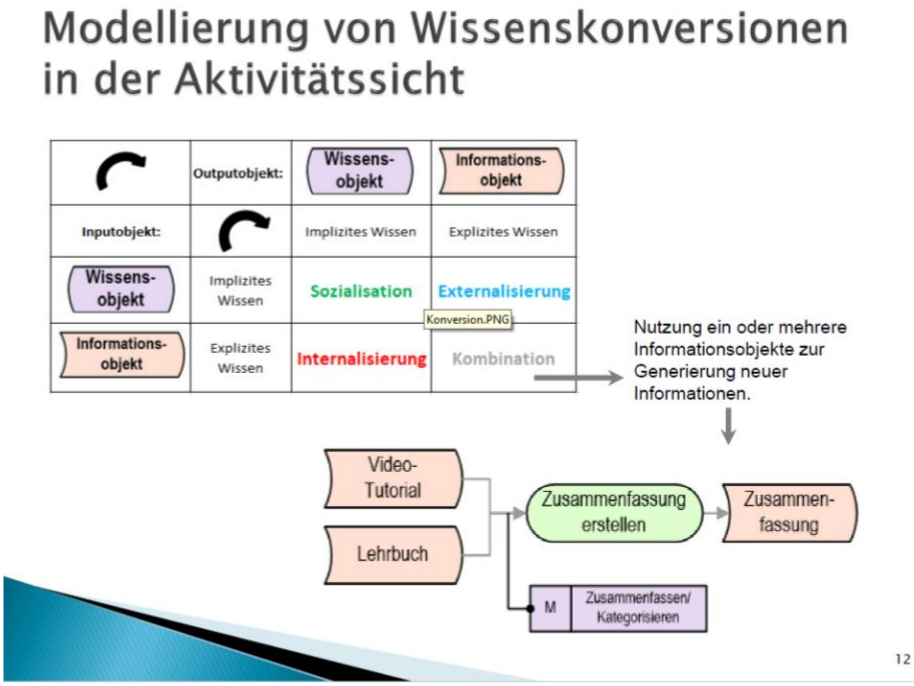

Figure 2. Slide of the traditional unit.

After the presentation, the students got exercises to solve. They had to solve several tasks by themselves. The professor and an assistant looked at their work and were ready to help and answer questions. Figure 3 shows one of these tasks.

3. Fallstudie zur Kommunikationssicht

Am 15. März um 13:00 Uhr verabreden sich Angela und Bernd in der Cafeteria, um ihre Semesterpläne zu vergleichen und evtl. weitere offene Fragen zu klären. In der Cafeteria diskutieren die beiden Studenten darüber, welche Voraussetzungen die Studierenden erfüllt haben sollten, damit sie die Module aus dem letzten Semester belegen dürfen. Angela behauptet, dass die Belegung der Module nur nach dem erfolgreichen Abschluss des Praxissemesters möglich ist. Bernd ist sich unsicher und recherchiert darüber in der SPO. Da er die Information darüber nicht findet, ruft er einen Mitarbeiter vom Studienbüro an. Die Information von Angela wird ihm vom Mitarbeiter bestätigt.

Modellieren Sie den **Ablauf der Kommunikation** zwischen den beteiligten Personen mit Hilfe der KMDL-**Kommunikationssicht**.

Hilfstabelle:

Person	Ebene	Person	Kommunikations-mittel	Zeit und Ort	Geplant/ ungeplant		
Angela	Cafeteria	Bernd	Gespräch	gleiche Zeit, gleicher Ort	geplant	2h	Frage klären

Figure 3. Task of the traditional unit.

5. The E-Learning Unit

Moodle is an open-source learning management system (Moodle, 2019). In Moodle, the learning content, such as text passages, images or videos, is available in a digital course room. This content can be enriched with various gamification elements. Levels can be created, which are a requirement for progressing to the next level. Self-control options can also be incorporated, for example as a quiz. All students of the Technical University of Nuremberg are provided with a Moodle account at the beginning of their studies. The students of the Technical University of Nuremberg are familiar with the software.

In advance, a project team of four students developed a Moodle course for the KMDL unit. For this study, twenty students took the course at the university. To get comparable results, they had also sixty minutes time for their unit. A professor and an assistant were present and advised the students. Time and place were fixed for the event. This means that the advantage of independence from date and time does not exist here. In return, the students had the possibility to ask for advice.

The subjects of the traditional unit and the e-learning unit were the same. The e-learning unit consists of several small lessons. After every lesson, exercises are provided. Figure 4 shows the start of the e-learning unit.

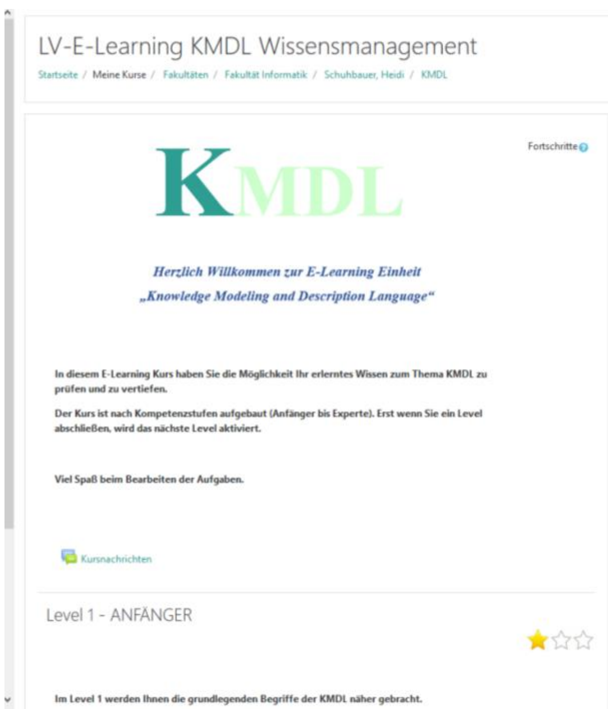

Figure 4. Start of the e-learning unit.

Figure 5 shows one of the exercises the students had to perform. This example is an assignment task. It is a drag-and-drop activity. The students had to assign knowledge objects to the category “explicit knowledge” or “implicit knowledge”.

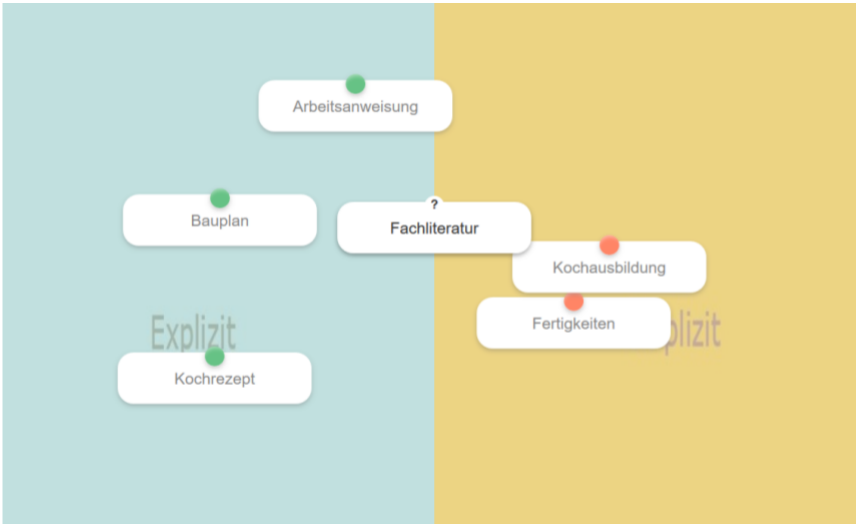

Figure 5. Task of the e-learning unit.

6. The Test

Next, the learning success of the students was assessed. A small quiz had to be taken by the students immediately after the e-learning or practice unit. It was not graded and could be handed in anonymously. It was only used to compare which group understood the material better. For this purpose, a quiz was developed which the students had to take. This test was the same for both groups. It consists of short questions referring to the complete learning material. Afterwards, it was checked at which questions significant differences occur.

As shown in Table 1, the result of the quiz was that the group with the traditional lesson achieved results that were slightly better than the e-learning group. However, these results are not statistically significant because of the small group sizes. The null hypothesis for the two-sample t-test was that the average test results of the e-learning group and the traditional taught group did not differ. Since t is not in the critical range at a significance level of 5% (t=1.2783; Range -0.2024 to 0.2024), the null hypothesis is confirmed. Therefore, from these results we cannot draw the conclusion that the traditional unit imparts learning content better than an e-learning unit. On the other hand, we can assume that there are no major differences in the amount of learning effort required when attending a traditional unit or an e-learning course.

Table 1

Comparison of the test results of both groups

	Group E-Learning	**Group Traditional Unit**
Number	20	20
Average	15	16.5
Standard Deviation	2.85	2.84
t	1.2783	
Range	-0.2024 to 0.2024	

7. Evaluation

In the next step, the students were asked how they assess their lessons. They assessed whether and how well they liked the unit presented, what they liked and disliked, and which learning kind they would prefer. Parts of this questionnaire were:

- Personal information about the students, such as their qualifications and their progress in their studies
- Questions about the contents of their lessons, such as the quality and amount of the exercises and examples and the level of the material
- Questions about the teaching method, such as comprehensibility, motivation, and assistance
- Questions about the acceptance of their unit, such as personal motivation, personal assessment of the lessons' quality.

Table 2 shows an overview of statements that compare acceptance and satisfaction with the courses. The students rated how much they agree with the statements listed in the table. While the average satisfaction with the course, the type of information provided or the type of teaching hardly differs for most questions, there are sometimes differences in the standard deviation. Excluding the first question, there was a dispersion of student opinions in the e-learning course.

Table 2

Comparison of the evaluation results of both groups

Question		**Average**	**Standard Deviation**
The unit was motivating.	**E-Learning**	**72.6%**	**19.2**
	Traditional	**67.5%**	**21.6**

The unit was comprehensible.	**E-Learning**	**78.6%**	**21.3**
	Traditional	**77.6%**	**14.2**
The presentation was appropriate.	**E-Learning**	**78.8%**	**23.3**
	Traditional	**78.8%**	**14.7**
I am content with the unit.	**E-Learning**	**82.5%**	**20**
	Traditional	**81.3%**	**13.8**
I prefer this kind of lesson.	**E-Learning**	**76.2%**	**27.9**
	Traditional	**82.5%**	**14.2**

8. Future work

The number of the participants in the test was not high enough to achieve statistically significant results. Building the two groups, the different levels of the students were not considered. To confirm whether the results achieved in this project are valid, the experiment will be repeated during the following summer semesters. More test groups could improve the project results achieved.

For the interpretation of the results, it is necessary to know that they depend on the quality of the teaching units evaluated. Results of the traditional unit depend on the quality of the teacher. Results of the e-learning unit depend on the quality of the e-learning course. In conclusion, it will remain difficult to explain whether one teaching unit is better than the other. However, some statements about the learning efforts and about the students' preferences could potentially be validated.

Acknowledgements

This work was supported by a grant from the STAEDLER foundation, as part of the project DIAMINT - Digitization of the student life cycle to support underrepresented students in STEM studies.

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PREDICTING PERFORMANCE AND ANALYZING STUDENTS' BEHAVIOR FROM COMPUTER-GENERATED LOG FILES IN MOODLE

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Abstract

This paper presents the results of the investigation into whether the student's behavior in the e-classroom in terms of action logs correlates with their academic performance. The empirical research was based on logs obtained from Moodle, which is used to manage blended learning at the faculty. The main finding from this research is that there is some relationship between some types of interactions and academic performance in selected online courses. The findings of the paper confirm that by monitoring Moodle activity data, lecturers can identify weak students and promptly adjust and individually support their pedagogical activities during the semester.

Introduction

Blended learning (BL), a combination of traditional face-to-face learning and technology-mediated instruction, is becoming common at all levels of education, and higher education is no exception. E-learning systems supplemented by face-to-face courses are known as learning management systems (LMS), learning platform (LP), course management systems (CMS), learning content management systems (LCMS) or managed learning systems (MLS) (Romero, Ventura, & García, 2008). Although known by different names, they are all used to manage online learning and teaching. One of the most popular LMSs worldwide is Moodle, which is flexible, open source and free. On the other side, it is user-friendly and well supported (Cabero-Almenara, Arancibia, & del Prete, 2019). In online courses, teachers: deliver to students information, content and learning materials; prepare assignments or quizzes; and manage collaborative learning with discussions in forums, workshops or wikis. Online courses offer different opportunities for adapting learning processes suited to the individual student's needs, abilities and learning style.

Each time a user accesses an LMS with his/her user account, a digital trace is saved in log files. A user's behavior in online course, i.e., activities and interactions with the system or other users during learning process, is therefore recorded. Each day the LMS collects huge amounts of data in digital format and accumulates the learning history of each user in log files. But we are not limited just to data from the LMS; we can also include demographic data and other student data from the information student systems (Romero & Ventura, 2013) The challenge is how to capture, process, present and use this data to make better decisions for tomorrow (Daniel, 2017). Accordingly, a new field of research rises with big data and analytics in higher education (Baker & Inventado, 2014; Ferguson, 2012). In recent years, learning analytics (LA) has become an important research trend and, as Elias (2011) said is “the measurement, collection, analyzing and reporting of data about learners and their context for purpose of understanding and optimizing learning and the environment in which it occurs”. LA explores learning log files and other educational data, as well as learners’ profiles, to provide proposals for improving learning processes and educational outcomes (Ferguson, 2012; Conijn, Snijders, Kleingeld, & Matzat, 2017). Different data mining techniques and tools are used to analyze accumulated data to discover useful information and patterns, commonly named educational data mining (EDM), such as prediction, clustering, classification, outlier detection, relationship mining, and visualization techniques (Chatti, Dyckhoff, Schroeder, & Thüs, 2012). These methods are used to get a more objective view on students’ behavior in online courses and evaluate this behavior to help improve the teaching and learning processes in the system (Romero et al., 2008).

The primary goal of educational institutions is to maximize the success of learners. Therefore, predicting learner performance from LMS data now presents a challenge. Many researchers investigate the possible correlations between students’ involvement in online course and their performance, usually based on the final grade for the course. Due to a wide range of online sources and activities, such as announcements, links, lecture notes, files, resources, questions and answers forums, discussion forums, quizzes, group works, wikis or assignment submissions, several studies have already explored impacts of various online events in different educational environments and courses. However, there is no general conclusion about the single best way yet to predict the performance or the online behaviour of potential students at risk (Conijn et al., 2017).

In the current study we analyze if there exists a relationship between students’ behavior in the e-classroom (number of logs in the e-classroom, number of visited activities, etc.) and their academic performance as measured with the final grade. The paper is arranged in the following way. First, there is a literature review or related works, followed by the empirical study, including the description of data, methodology and results. The paper concludes with key findings.

Related Works

BL educational data comes from different resources: traditional face-to-face classroom and online course environment, where the second source of data is a richer source of information about the learning process. In recent years, many studies analyzed LMS data in order to predict a student’s academic performance and usually take into account the final grade or simply whether the student has passed the final exam or not (Conijn et al., 2017; Romero, López, Luna, & Ventura, 2013; Romero, Espejo, Zafra, Romero, & Ventura, 2010; Zacharis, 2015). Studies have addressed different types of courses and various selected variables taken from LMS data; therefore, comparison of results is difficult. The general conclusions about the predictors could not be readily deduced (Conijn et al., 2017). Some studies attempt to detect patterns of students' behavior in online courses and discover students who are at risk more than likely will not complete the course (Félix, Ambrósio, Neves, Siqueira, & Brancher, 2017). Such predictions could help teachers to take steps towards bringing the students back to the course before is too late.

Determining the factors affecting academic performance is the focus of many studies. Many researchers seek associations between learners who passed or failed a course and student learning through collaboration or interaction in the online course, namely forum posts, quiz attempts and assignment submissions. This is certainly not surprising, as in those activities, a student actively participates and demonstrates the acquired knowledge.

In studying Moodle log files, Zacharis (2015) investigated online activities in a BL course trying to predict final grades. The focus was on the usage (or participation) time on the activities. Findings reveal that a high level of communication in online activities, such as posting messages on forums and content creating (wiki, blog), strongly correlates with final course success. Similar conclusions were made by Romero et al. (2013) when investigating different data mining technique to predict university students' final performance based on their participation in an online discussion forum in a first-year computer science course. They were able to make an early prediction if a student will pass or fail at the end of the course, considering only students' posts with a subject's content. A very different conclusion was made from a survey that included 17 different courses, namely, a discussion forum and wiki usage had the lowest percentage of significant correlations with final exam grade (Conijn et al., 2017).

Quiz activity in LMS Moodle can be configured in various forms with automatically generated feedback and score marks, showing the correct answer or not; therefore, it allows learners to check understanding of the study materials and acquired knowledge almost immediately. Due to a wide range of different learning purposes for which quizzes can be used, they are an almost indispensable part of the e-course. Possible variables observed are number of quizzes viewed, number of attempts per quiz, number of quizzes failed/passed, (total) time used in a specific quiz or all quizzes etc. (e.g., Conijn et al., 2017; Rebucas Estacio & Callanta Raga Jr., 2017; Kadoić & Oreski, 2018; Romero et al., 2008; Zacharis, 2015). However, except for the case of Zacharis (2015), those preliminary surveys take into account compulsory quizzes, so all the students had to attempt them. In the case of the survey of Zacharias (2015), quizzes were optional with unlimited access with no impact on final score. His results revealed that the higher final course scores of students were associated with a higher number of attempts in online quizzes. Therefore, it can be deduced that only motivated students used quizzes to revise learned material. Using classification techniques with an if-then-else rule, Romero et al. (2008, 2010) classified students into four categories. Classification into fail or excellent categories (determined by final grades) is mainly based on the number of passed quizzes; therefore, a teacher can detect a student with learning problems to give him additional support and motivation in a timely manner.

In BL courses, self-regulation strategies in learning are important and critical to success. From LMS log data, self-regulated factors are usually measured with frequency (You, 2016): number of logins, number of content views, time spent reading pages, etc. However, the time a student spends and the number of logins and hits in an online course were found to be insignificant factors in predicting student's performance (Rebucas, Estacio, & Callanta Raga Jr., 2017). On the contrary, Kadoić and Oreski (2018) studied Moodle log data of one course and reported that the students' final grades correlate with the number of logs in the e-course. Moreover, the results revealed that students with the highest grade completed the e-course activities just before the deadline. A different conclusion was revealed by You (2016) in his study, namely, regular study has the strongest impact on the course achievement, and late submissions (negative correlation) and login sessions are in the second and third places.

In line with these studies, hereinafter, we analyzed how the students' behavior in the selected e-classroom (Basic Statistics) is related to their performance to see if the results are in line with the literature reviewed.

Research

Data and methodology

Our data sample consisted of learners from the 1st year of a professional study programme at the Faculty of Public Administration (FPA), University of Ljubljana. In each academic year, this group of students is the largest homogeneous group of students at the FPA. For our analysis we selected the course, Basic Statistics, which was held in the first semester and has plenty of activities in its e-classroom. Every week, students have three hours of face-to-face lecture, and for the remaining one hour, study materials and activities are prepared in the e-classroom. For the tutorial, three extensive assignments are prepared in e-course during the semester and the teacher gives feedback on the correctness of the solutions; in the 12 weeks, the tutorial is held in the traditional way. In the academic year 2018/19, the total number of the students enrolled in the e-classroom was 244; 52 of them never entered the e-classroom so it was impossible to analyze their behavior. Therefore, we limited our analysis to the 192 (79%) "active" students.

The e-course Basic Statistics contained 90 activities (available to all students):

- 25 quizzes which replace 15 hours of traditional face-to-face learning, i.e. their content is not held in face-to-face form;
- 21 folders with content used in the teaching/learning process – most of the folders (16 out of 21) contain slides and files that are used in face-to-face lectures; 5 folders contain files that are needed for three tutorials held in e-classroom;
- 20 links to sites in the e-course that contain hints and explanations for solving quizzes;
- 15 links to files that are used for students' self-preparation for the lectures;

- three assignments that replace six hours of traditional face-to-face tutorials;
- two forums: an announcement forum and a forum for student discussion;
- four activities that are not directly related to the course but provide interesting content related to the subject matter.

Quizzes were the most visited activities in the e-course Basic Statistics. The primary reason is that students' participation in quizzes is evaluated and represents 20% of the final grade mark. Each student has at least three attempts per quiz and the final score from a quiz is the best score out of three attempts. That stimulates the students to use multiple attempts to achieve better scores. The other activities were not visited so frequently. Although many folders contain slides and files that are used in face-to-face lectures, students typically visit these folders once and download the study material. The study materials for self-preparation are not visited so frequently since self-preparation is not obligatory and does not contribute to the final grade score. Similarly, the assignments that replace face-to-face tutorial for individual work at home and for which the teacher should review and give feedback to students about the correctness of their submitted solutions, have no influence on the final grade. The e-classroom contains two forums – the forum for students' discussion had no entries while the lecturers posted 12 topics in the announcement forum. The basic information about the course (contact information about the lecturers, students' obligations, etc.) do not belong to specific activities. They are found on the course's home page.

For the purpose of our analysis we counted how many times each student visited each activity. We collected the records from October 1st, 2018 (the beginning of the semester) to February 15th, 2019 (the end of exam period). Altogether we collected 98,213 records, which means that on average each student had 512 activities in the e-classrooms. On average, each activity has been visited 5.94 times per student.

Most of the activities belong to the logs to the e-classroom (40,865). That means that, on average, students visited the e-course Basic Statistics 213 times in the semester (i.e., an average 1.55 logs per day). The second most visited activity is the quiz intended as preparation for the first mid-term exam. It was visited 4,059-times, i.e., 21 times on average per student. Most of the quizzes appear at the list of top visited activities (Table 1). For our analysis we chose 25 activities with more than 6 visits per student on average (above the overall average which equals 5.94). Table 1 summarizes these activities with the average number of visits by student. The activities are sorted in descending order in terms of the average number of visits per student.

Table 1

25 activities in the e-classroom with the highest number of average visits per student (n=192)

Activity	Avg. visits per student
visits to the e-classroom	212.84
quiz - Definitions	21.14
quiz - Gapminder	12.27
quiz - Statistical Office (1st part)	12.21
quiz - Indices	11.99
assignment 1	10.97
quiz - Statistical Office (2nd part)	10.19
quiz - Ranking	9.08
quiz - Frequency distributions	8.71
quiz - Time series - forecasting	8.49
quiz - Review quiz (1st part)	8.43
quiz - Ranking practical	8.33
quiz - Indices practical	8.31
quiz - Excel functions (1st part)	8.23
quiz - Sampling	8.19
quiz - Correlation and regression	8.05
quiz - Hypotheses testing	7.99
quiz - Probability	7.91
assignment 2	7.89
quiz - Measures of central tendency and variability	7.41
quiz - Frequency distributions - practical	6.87
quiz - Excel functions (2nd part)	6.66
quiz - Time series - practical	6.54
quiz - Review quiz (2nd part)	6.32
quiz – Definitions of statistical terms	6.20

From the Table 1 we can see that the most-visited activities are quizzes. The exceptions are the number of visits to the e-course and the first two assignments. Most of the quizzes with the highest number of visits belong to the topics that are covered at the beginning of the course schedule. Notice that some of the quizzes have two parts (1st part and 2nd part). In contrast to the ordinary quizzes, they did not cover a specific topic but combined several. Their purpose was to prepare students for the two mid-term exams.

In the paper, we investigate how the students' behavior in the e-classroom Basic Statistics is related to their performance. For this purpose, we added a 0/1 variable describing if a student passed or failed the exam. Out of 192 active students, 126 attended the exam; 102 (81%) passed the exam, and 24 (19%) failed. We limited our survey to the 126 students who attended the exam. We compared mean number of visits for activities from Table 1 using Student's t-test for independent samples (two groups: passing and failing the exam). Due to the large number of tested hypotheses we applied the Bonferroni correction of p-values.

Results

Table 2 represents the comparison of two groups of students (passed/failed) in terms of mean values of 25 most visited activities. For each activity we calculated the average number of visits and its standard deviation for both groups. We then computed p-values using the t-test for independent samples. Significant differences (after the Bonferroni correction) are marked with stars. Table 2 is sorted in ascending order by p-values. That means that the most interesting findings appear at the top of the table.

Table 2

Comparison of mean number of visits of 25 activities between students who passed and who failed the exam. The Student's t-test was used for computation of p-values

Variable	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**	**Significance**	**Prob.**
	pass (n=102)		fail (n=24)			
quiz - Ranking practical	14.30	8.65	3.13	4.54	6.316E-13	***
quiz - Review quiz (2nd part)	11.29	8.55	2.29	3.61	3.897E-12	***
quiz - Excel functions (2nd part)	11.86	8.04	2.75	3.85	5.607E-12	***
quiz – Definitions (2nd part)	36.16	26.22	8.38	11.92	1.763E-11	***
quiz - Hypotheses testing	14.25	10.71	3.17	4.90	4.639E-11	***
quiz - Correlation and regression	14.29	9.79	3.42	4.97	4.868E-11	***
quiz - Time series - forecasting	11.67	9.65	2.63	4.37	9.489E-10	***
quiz - Frequency distributions – practical	11.55	7.46	3.13	4.42	1.184E-09	***
quiz - Probability	13.77	10.39	3.75	5.97	4.013E-08	***
quiz - Frequency distributions	14.23	9.49	4.42	6.38	1.474E-07	***
quiz - Time series – practical	14.24	8.48	4.33	7.32	5.804E-07	***
visits	324.11	144.66	163.25	151.06	3.466E-06	***
quiz - Review quiz (1st part)	13.53	8.44	4.79	6.49	5.653E-06	***
quiz – Definitions (1st part)	10.33	7.16	3.13	4.77	7.241E-06	***
quiz - indices practical	13.45	8.16	4.88	7.85	7.901E-06	***
assignment 1	15.55	8.66	7.29	6.71	2.616E-05	***
assignment 2	12.40	10.60	4.67	7.25	9.122E-05	**
quiz - Statistical Office (2nd part)	15.58	9.90	7.79	8.04	4.881E-04	*
quiz - Sampling	14.05	11.34	5.33	8.58	5.820E-04	*

Variable	Mean	Standard Deviation	Mean	Standard Deviation	Significance	Prob.
quiz - Excel functions (1st part)	12.56	8.83	6.29	8.41	2.000E-03	*
quiz - Gapminder	17.12	11.87	9.00	9.60	2.274E-03	
quiz - Indices	17.10	11.98	10.08	10.96	9.844E-03	
quiz - Ranking	12.80	8.79	8.00	8.86	1.764E-02	
quiz - Measures of central tendency and variability	10.31	7.21	7.17	7.30	5.725E-02	
quiz - Statistical Office (1st part)	14.87	7.90	11.96	7.50	1.032E-01	
Probability level of significance: *** < 0.001, ** < 0.01, * < 0.05						

Table 2 indicates that we discovered significant differences between the two groups of students in terms of most activities. The mean number of visits is always higher in the group of students who passed the exam. This indicates that students who are more active in the e-classroom achieve better results on the final exam.

Conclusions

In the paper, we investigated how the students' behavior in the selected e-classroom (Basic Statistics) is related to their performance. The empirical findings imply that level of activity in the e-classroom is strongly related to the final success on the exam. We found that students who passed the exam had on average more visits to activities in the e-classroom compared to those who failed. We also identified which activities were the most discriminatory between the two groups. At the top of the list appear the quizzes which were designed for the preparation for the second mid-term exam (review quiz, Excel functions, definitions of statistical terms) and more advanced statistical topics (hypotheses testing, correlation and regression). The single exception is the quiz that covers topic of "Ranking". According to previous literature and our empirical results, regular monitoring of the Moodle activity data can help lecturers of the courses to identify weak students and promptly adjust and individually support their pedagogical activities during the semester.

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BLENDED LEARNING IN LSP ACADEMIC PROGRAMMES: CHALLENGES AND BENEFITS

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Abstract

Extensive use of technologies has brought many changes into different aspects of life, including teaching and learning. Teaching and learning languages are not exceptions and they have witnessed tremendous changes in the past 25 years. These changes put the need to learn languages to improve communication into spotlight. Language for Specific Purposes (LSP)—aka ESP: English for Specific Purposes—programmes strive to prepare university graduates who are linguistically and communicatively proficient and adequately accurate in their areas of expertise. This paper is an attempt to address some of these challenges in university LSP programs and offer possible solutions.

Keywords: Blended Learning, ESP, LSP, CALL, MALL, hybrid learning, mixed mode learning, online and face-to-face modalities

Introduction

Due to the evolving nature of BL (blended learning), and considering the different context in which BL takes place, there are still several variations in defining BL. Since blending can happen though applying some mixed regime of online and face-to-face, through diversifying the different possible delivery methods, and through applying a variety of instructional methods, definitions of BL usually tend to pay more attention to one of them. However, in this paper, BL is used to mean the learning that is the product of combined doses of face-to-face and online instruction (Graham, 2013).

Creativity and innovation are the two most important characteristics of the 21st century education. They also play a major role in blended learning. Depending on the context and purpose of learning, there are different models of BL. The increase of BL learning in K-12 contexts (Picciano, Seaman, Shea, & Swan, 2011) has mostly been an "alternative to purely online models", requiring physical supervision of students during the school day (Wicks, 2010). This model, according Watson (2008), includes eight dimensions, as shown in Figure 1:

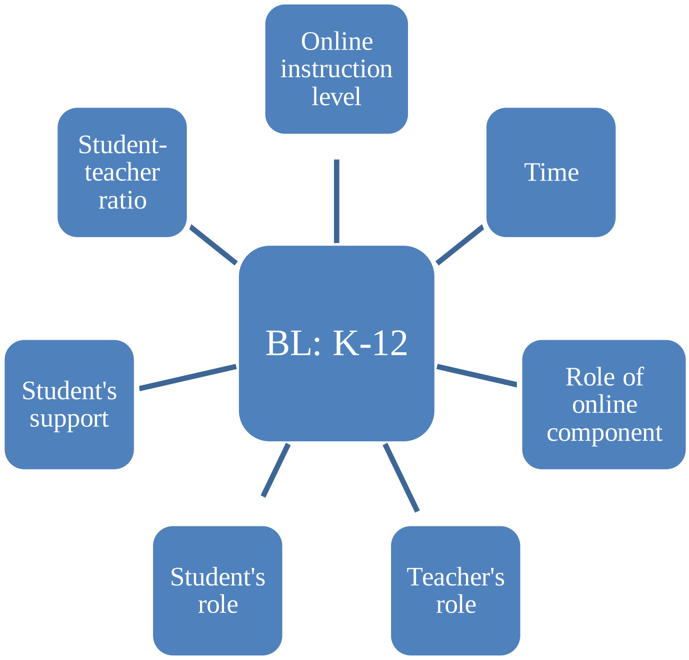

Figure 1. Watson's K-12 BL Model (Watson, 2008).

However, perhaps one dimension is missing from Watson’s model, and that is “Teacher’s Support”. Therefore, I suggest a modified model for K-12 blended learning, as seen in Figure 2 below. The teacher’s support can be extended through institutional support, professional development/learning or through some mentoring programmes. It is predominantly the case that the university teaching staff is on the top of their disciplines; however, there is always the need for training and retraining since technology is always evolving.

The explosion of information and the need to disseminate, analyse and use information have made the need of corporations to train/retrain the staff even more paramount. Here again, BL has come to prove very useful. However, the model followed in BL in corporations has its own characteristics, which represent a combination of classroom instruction, independent online learning, and a teacher’s guided online learning in both formal and informal learning modes, both synchronously and asynchronously.

In higher education, BL has been gaining increasing popularity. Many researchers now strongly believe that BL will be the major course delivery method in the future of higher education (Norberg, Dziuban, & Moskal, 2011; Lim & Wang, 2017). In higher education, technology predominantly helps to reinforce the previously learned items, or it may be used to fill the gap if learning is disrupted (Diaz & Diniz, 2012). Moreover, there is a different realization of the kind of knowledge HE students need to acquire, the organization of the teaching process, and the learning materials to be created (Torrao & Tiirmaa-Oras, 2007).

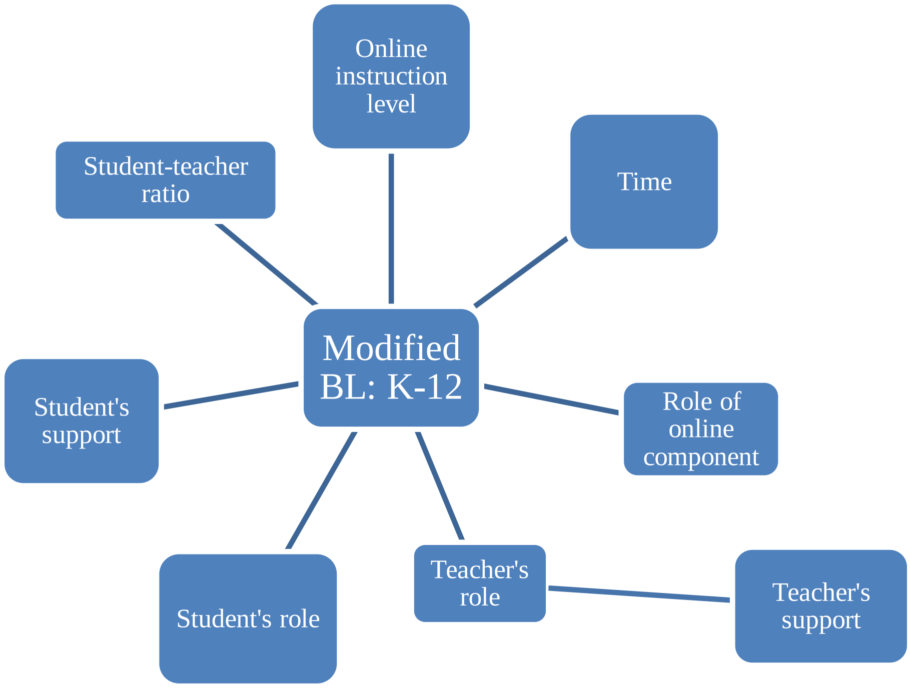

Figure 2. Modified BL K-12 Model.

Blended Learning: Strategic Components

Devising and developing optimised and coherent blended learning programmes in higher education institutions require the identification and integration of multiple strategic components: vision; curriculum; policy and institutional infrastructure; technological infrastructure and resources; support mechanisms; and partnerships.

Vision

Vision outlines the organisational objectives that guide and formulate the process of decision making and serves as the organisational road map. In other words, the mission of a higher education institution clarifies where on the higher education map it currently stands and where it is heading to. Long and detailed, visions historically used to be "descriptions of the institution's founding, curricular history, unique culture and current services" (Hinton, 2012). However, these days, vison statements of higher education institutions mostly pronounce the institutional aspirations that reflect the institutional environment present in the given institution. To sum up, the vision of a higher institution expresses what it currently is and what is intends to become.

Curriculum

The term "curriculum" has been defined differently through the modern history of education. Instances of curriculum definitions include:

- the collection of different learning outcomes in a structured manner (Johnson, 1967);

- a method of communicating the critical "principles and features" of an educational concept open to scrutiny and capable of being "translated into practice" (Stenhouse, 1975);
- a formulated rationale-based version of an educational proposal to be implemented (Jenkins & Shipman, 1976);
- an organised set of goals that outlines the plan of formal education and training intentions (Pratt, 1980);
- a plan and a blueprint of learning experiences planned for the students (Hass, 1987);
- the syllabus to which is added the "planning to a consideration of the content or the body of knowledge that they wish to transmit" (Smith, 1996, 2000); and
- comprehensive planned and guided learning experiences individually or otherwise in and out of school (Kelly, 2004).

According to UNESCO, designing curriculum is an attempt towards packaging a set of competencies that learners are supposed to acquire via organised learning experiences that occur formally and informally (UNESCO, 2016). This view on curriculum gives considerable room to formative assessment, and blended learning lends itself well to formative assessment as it is possible to render individualised responses to learners.

Policy and Institutional Infrastructure

Technological and societal changes have dramatically affected different aspects of life, including education, and particularly higher education. Organisational change and development are strongly supported by proper organisational structures so that they can render the change they envision (De Freitas & Oliver, 2006; Jalkanen, Pitkänen-Huhta, & Taalas, 2012). Higher education should develop plans with specific guidelines to cater to the smooth delivery of blended learning programmes in a manner which engages both students and faculty members. Considering that "creativity" and "innovation" are the two major pillars of the *21st century education*, it would be difficult to imagine that they can be materialised without "autonomy" and "freedom", which cannot flourish and further enhance education unless there are well-defined policies.

Technological Infrastructure and Resources

Technology is said to be the facilitating means to bring change, though it does not bring change per se (Allan, Law, & Wong, 2003). However, how deeply a higher education institution is ready in terms of technology is an important factor to consider when blended learning is in perspective (Niemiec & Otte, 2010). A higher education institution which intends to set up and run a blended learning programme needs to make sure it has the right physical and virtual infrastructure. It becomes quite important to foster an adequate delivery of the content and building capacity for foreseeable future developments.

Support Mechanisms

Students as well as teachers often use the technology they have for communication and entertainment purposes rather than "gather and constructing knowledge" (Wang, Hsu, Campbell, Coster, & Longhurst, 2014). This is an indication that they might not have had a first-hand experience of using technology for learning purposes. Both teachers and students need training and support to gradually feel comfortable with educational technology. Higher education institutions should facilitate learning support centres to advise students and teachers on the use and best practices of using technology. This would, in turn, help develop teachers and students into independent life-long-learners, the quality that 21st century education actively promotes.

Partnerships

Different academic departments within a higher education organization often forge partnerships towards pre-defined objectives. Higher education organizations also often sign memoranda of understanding (MoUs) towards mutually interesting projects. In either of these cases, there is always the element of a "common goal" (Shubber, 2008) while partners tap into each other's resources. This also prevents taking duplicate actions or developing unnecessary programmes.

Lim and Wang formulated the strategic components of BL in higher education as seen in Figure 3 below.

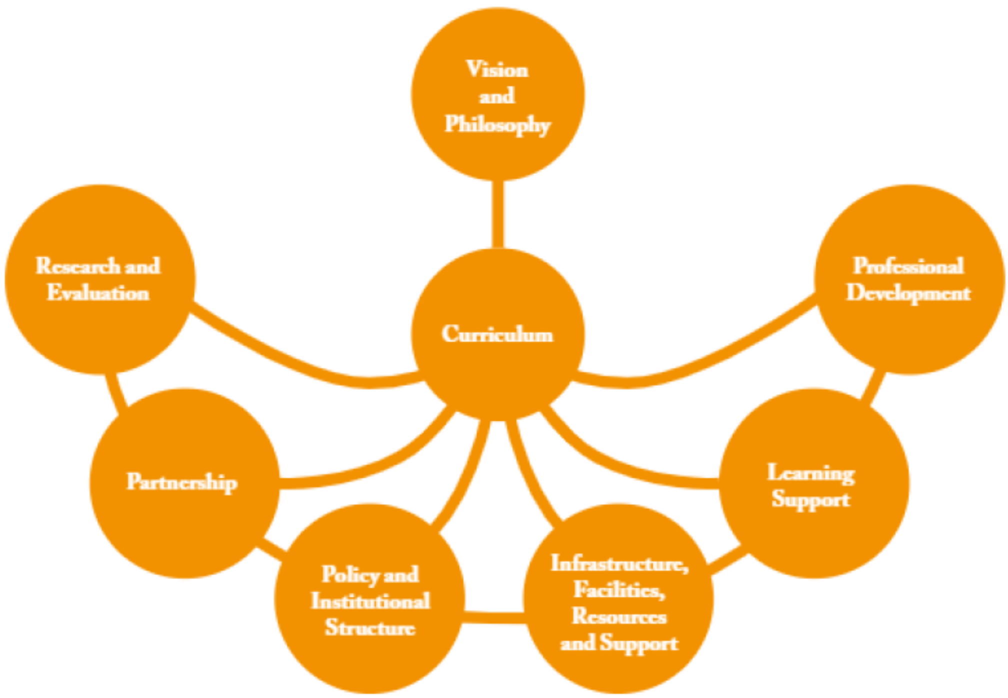

Figure 3. A holistic framework for building the blended learning capacity of higher education institutions (Lim & Wang, 2017).

Blended Learning Models in Higher Education

Today, most BL activities in higher education follow one of the following models:

1. *Blended face-to-face class*: Learners have access to the technology in face-to-face classroom and teaching alternates between the face-to-face and the online modes.
2. *Blended online class*: Learners mostly use the online component; however, some class time or lab time is needed for the further reinforcement of the items to be learned.
3. *The flipped classroom*: Students watch short online lecture videos and cover some study materials. They then come to class to work on collaborative projects or to do exercises.
4. *The self-blend model*: The online component is not actually part of the educational program. However, students choose to enrol in totally online programmes that would supplement the face-to-face courses
5. *The blended MOOC*: Learners choose to use a Massive Open Online Course (MOOC) and choose to have some face-to-face meetings to supplement the learning process.
6. *Flexible online model*: Learners choose to study courses that were designed with dynamic, varying doses of online and face-to-face learning events.

Language for Specific Purposes (LSP)

Language programmes in higher education strive to help students acquire enough language knowledge skills so that they are able to constructively function in professional and social contexts using the target language. Using relevant methodologies, Language for Specific Purposes (LSP) courses are designed to deliver content in the target language based on an identified set of specialized needs. In other words, contrasted with Language for General Purposes (LGP), LSP combines linguistics and content area knowledge specific to a particular context based on the learners' needs. As can be seen from Figure 4 below, the process of developing an LSP course involves: (1) needs analysis; (2) determining goals and objectives; (3) assessment; (4) materials selection and development; (5) teaching; and (6) program evaluation.

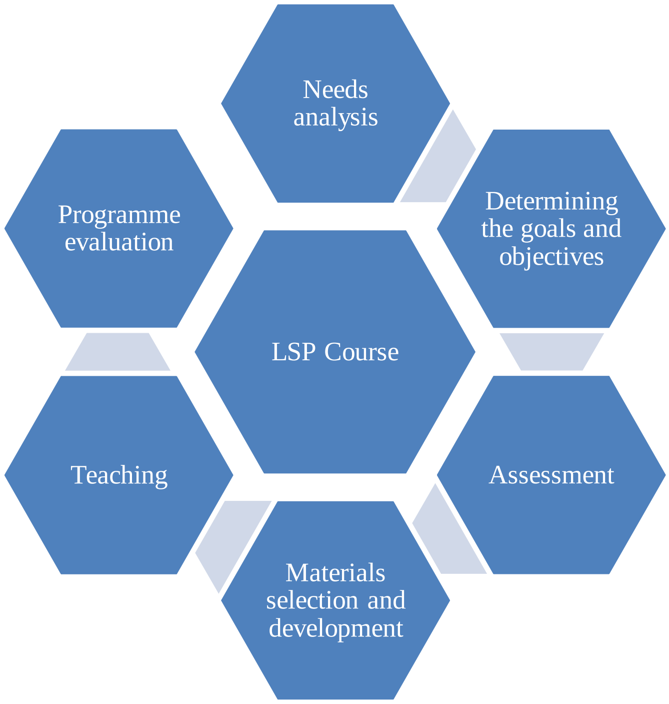

Figure 4. Steps of Developing an LSP Course.

The labour market in the 21st century has witnessed massive transformations posing new and different demands on university graduates and university lecturers. This means that the knowledge and academic skills learners acquire during their studies should be "applicable and transferable from the higher education context to their future professional careers" (Knezović, 2016). Considering the teaching context of LSP, the teachers' objective is not merely teaching the language per se; it is also to prepare students to use that language as a medium to develop the skills and competencies relevant to the discipline being studied. These include competencies and multiple literacies such as media and information literacy, critical thinking, creativity, cultural awareness, discipline-related ethics, problem-solving and analytical skills, effective written and oral communication skills, and collaborative and social skills, all necessary and instrumental in making university graduates more competitive in everyday professional environments. Yet, as a result of limiting factors such as time, teacher-student ratio, and predominantly topic-based syllabi, LSP courses focus largely on teaching the subject matter and specialist vocabulary instead of "sufficient development of skills and competences required by students' prospective employers ." (Knezović, 2016)

To make up and circumvent the above-mentioned limiting factors, an increasing number of teachers and students have begun considering and adopting BL in LSP teaching and learning.

Challenges

Teaching languages still has some unanswered questions. For example, the debate still continues as to how languages are learned, what is the role of the first language (L1) in learning a second and/or a foreign language, whether gender plays any role in learning a new language, etc. When technology, a new parameter, is also added, it is difficult to imagine that it should not bring new challenges to the game.

Technology Challenges

In order to deliver content in the online segment of a BL program, the required software is needed; however, teachers are not predominantly software developers and the majority of software developers are not language teachers. Moreover, students might not necessarily be familiar with all the features of given software, and they might need training. To sum up, troubled by technology, participants may be likely to abandon the program, thereby leading the program to failure.

Organizational challenges

The success or failure of any innovative approach in academia (like any other organization) depends on how deeply the organization supports and advocates the innovation in question. Different studies show that organizational support plays an important role in the success of different academic programmes. (Ersoy, 2014; Eisenberge, Huntington, Hutchison, & Sowa, 1986; Randall, Cropanzano, Bormann, & Birjulin, 1999; Rhoades & Eisenberger, 2002). Quite often, academic policy and decision makers are not from a language teaching background and that hinders them from giving language teaching innovations their due support. For example, they might think that BL in teaching languages might not be as effective as a face-to-face teaching mode. There are also conceptual challenges, as the integration of technology has transformed some of the traditional definitions in education. For instance, a "classroom" is not necessarily a "brick-and-mortar" entity; it can be virtual, too. The role of a "teacher" is not to transfer knowledge to students unidirectionally; s/he is more of a "facilitator", a director of studies. Moreover, students' attitudes and perceptions are also affected when an innovative component is added to course. It can even affect the students' academic identities.

Assessment Challenges

In all academic programs, language teaching programs include students' progress and a course of activities need to be assessed, enabling them to go up the academic ladder. However, in the event of adopting a BL regime, how would the learner be assessed? Based on the face-to-face component? Based on the length of time they spend logged in the system? Based on performance in a formal exam? Would that exam be face-to-face, online or combined?

LSP-specific challenges

Due to the nature of LSP teaching, blended lessons could have particular intricacies. For example, learning languages on one's own requires a great amount of intrinsic motivation. Moreover, due to the discipline-oriented nature of LSP courses, different language items (technical terms, abbreviations, acronyms, etc.) are interpreted differently. LSP courses are rather formally structured. Therefore, in case that social media is used to blend an LSP course, the informal atmosphere of social media might find itself in some conflict with the formal structure of the course. Moreover, language teachers could get along with the integration of technology in teaching language for general purposes (LGP), but they will find the adoption and creation of LSP material more challenging.

Benefits

Although the adoption of BL in an LSP programme poses some challenges, it is beneficial in other respects. First and foremost, it increases motivation on the side of the learners. This becomes especially true when learners feel independent through carrying on a variety of different tasks. It also enhances the learners' sense of achievement.

One of the most important aspects of learning languages is the provision of authentic materials. Blended learning gives the opportunity to a language learner to have access to authentic language items and use them several times in order to master the target skill. The rather self-paced and self-controlled use of the authentic language item helps learners experience language in the context it is intended to. It also protects learners against developing fossilised errors.

Perhaps one of the key factors making LSP courses different from other courses is the "interactive" nature of language learning. Learning under formal circumstances, which is characteristic of learning in most disciplines, is rather linear. In math, for example, one needs to learn the basic four operations before venturing upon equations. Learning languages, on the other hand, is rather organic. Learners picks bits of the language from different interactions, put them together, make generalizations, deductions, revisions, and come up with their "own formula" to use the language item in question. The access to different authentic materials on the web, in fact, breaks the "linear flow of instruction" (Lee, 2000).

The interactive nature of learning in LSP might pose some challenges to students who are shy or might have reservations to produce language. The individualised nature of the online component of the blended LSP course and the collaborative nature of it will give these inhibited students the opportunity to blend in smoothly. Fast learners, on the other hand, do not prevent their colleagues from moving at their individualised paces.

One of the main features of learning language in the 21st century is gaining global cultural literacy. Different language contents created and shared on the web are culturally-loaded. Having the opportunity to observe and experience these language items can give learners the cultural awareness that would serve as the key to unlock many other language items they will come across in the future.

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DEBATE "PRO ET CONTRA" AS AN EFFICIENT METHOD FOR BUILDING PLURAL COMMUNITIES OF TEACHERS AND PhD STUDENTS IN A MUTUAL COOPERATIVE LEARNING PROCESS

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Abstract

Economic theory lost the capacity of an anthropocentric view of the world due to the domination of the neoclassical paradigm and the lack of pluralism within economics and beyond it. Debate is an appropriate educational method for introducing more pluralism into the education of today's PhD's students in order to foster their understanding of today's emerging problems. This paper presents debate "pro et contra" as a highly structured rhetorical event and disciplined conversation about topics of interest with opposing advocates alternating before a decision-making body. The qualitative analysis shows that debate increases students' capacity for critical, controversial and original thinking and that is a highly efficient method for promoting a more cooperative learning process. In this way, knowledge is necessarily dispersed and not given completely to anyone since it is embedded not only in a traditional one-way transfer of knowledge from teachers to students but also in debates, teamwork and class conversations.

Keywords: debate, neoclassical paradigm, pluralism, holism, cooperation.

1. Introduction

The education of today's economists is based on the strict methodological rules which foster domination of the neoclassical paradigm in economics and in the broad framework of social sciences. The divisions between and within the scientific community have become synonymous for partial analyses and mutual exclusion of ideas. Several authors therefore have pointed out the importance of pluralism and holism in economics (Mearman, 2007; King, 2004; Freeman, 2010; Söderbaum, 2008).

I believe that due to partial analyses, economic theory has lost its capacity of an anthropocentric view of the world. Thus, the pledge for a change in the education system of economists has been addressed on one hand by scholars (Barone, 1991; Goodvin, 2008) and on the other hand by students (e.g. the Post-autistic economics movement in France). Recent developments have also influenced our need to change the education system of economists. The global financial crisis (Big Recession) that erupted in 2007 has significantly intensified the controversy about the status of mainstream economics because of its failure to adequately grasp it (Blinder, 2010; Kowalski & Shachmurove, 2011; Colander, Foellmer, & Haas, 2009; Hodgson, 2011). The global financial and economic crisis raises the question of how this should be reflected in the education system of today's economists and their curriculum.

I strongly believe that debate "pro et contra" can help in changing the education system of today's economists. Debate is an equitably structured rhetorical event in the class about some topic of interest, with opposing advocates alternating before a decision-making body. I argue that debate can be used for promoting more pluralism and holism in the education of today's economists in order to better resolve today's problems. In my opinion, debate also enables students to be more engaged in the education process since the roles of the students and teachers change. The debate "pro et contra" enables us to build a new social framework in terms of how new ideas and arguments are produced through more pluralistic concepts and a more interactive process of social learning.

The main purpose of the article is threefold: (1) To argue that the neoclassical school has consolidated its monopoly position within economics and in the broad framework of social sciences; (2) To show that the lack of pluralism and holism in the education system of today's economists can be overcome through the debate "pro et contra"; and (3) To conduct a qualitative study in order to present debate as an efficient educational method for promoting a mutual cooperative learning process between students and teacher.

The article is structured as follows. In section two and three the dominance of the neoclassical school is presented. In section four, I point out the lack and importance of pluralism and holism in the (economic) scientific community. In section five, the debate "pro et contra" as a disciplined conversation is presented along with its protocol. In section six, a qualitative study about perceptions of debate as an educational method is presented in order to show how debate can be an efficient method for promoting more pluralism and holism within economics and for encouraging a cooperative learning process. The last section concludes by summarizing the main findings.

2. Neoclassical Paradigm

The theories that sprang up before the birth of modern science were related to everyday experience, and, as such, they relied heavily on the influence, intellectual breadth and perspicacity of the individual. Positivism broke the link between science and everyday experience to provide a solid foundation for those sciences that were willing to adopt the strict rules of the scientific method (Ule, 1992). The gist of the Popperian approach is to freely propose hypotheses that can withstand the harshest possible attempts of rejection (Popper, 1998). Positivism, with its rigorous methodology, stresses objectification of knowledge which is equated with classical physics (Blaug, 1992; Ule, 1992).

Economics has developed a relatively simple set of methodological apparatus, which results in a high level of unity among economists. The domination of the neoclassical paradigm has been often addressed in the economic community (Johnson, 1983) as an ideal for the majority of contemporary economists. Economics, with extensive use of mathematical formalism and statistical techniques, adopted the methodology of natural sciences. Worswick (1972) and Pheby (1988) go so far as to submit that economics has become indiscernible from mathematics, a discipline that represents the apex of scientific purity. Neoclassical methodology relies on deductive reasoning, bold testing of hypotheses, and checking the hypotheses against empirical facts. The starting point is the rationality from which equilibrium as the solution of agent maximization problems is inferred through deductive logic. It seems that mathematics has become the "lingua franca" of modern economics. The unity of textbooks and academic programs clearly illustrates the high level of domination of the neoclassical school.

A methodological approach that is based exclusively on mathematical tools and statistical methods is no longer adequate for today's circumstances. Many authors assert that neoclassical economics has relatively weak forecasting power since it has failed most conspicuously when attempting to provide practical advice. Goodvin (2008) and Freeman (2010) argue that the neoclassical school has neglected the consistency between theory and reality. Mayhew (2008) points out that orthodox economics is inadequate for providing an account of the lives of the vast majority of people. The global financial crisis (Big Recession) that erupted in 2007 has significantly intensified the controversy about the status of mainstream economics (Blinder, 2010; Kowalski & Shachmurove, 2011).

I believe that economic theory has lost the capacity of an anthropocentric view of the world because of its lack of willingness to communicate within its own and with other scientific disciplines. As a result, it falls short in its attempts to respond to contemporary challenges.

3. Paradigms and Divisions in the Scientific Community

Emancipation of scientific disciplines and institutionalization of science within particular scientific communities leads to divisions that hinder efficient communication between them. Attention of different scientific communities is focused on different problems, and the use of different scientific languages impedes mutual communication. As a rule, the results are verified and interpreted within individual scientific communities (Burell & Morgan, 1979; Hassard, 1993; Calas & Smircich, 1999). Divisions are becoming synonymous to partial analyses, localized worlds, and the mutual exclusion of ideas. The level of communication is as a rule higher within a particular scientific community than between different scientific communities.

Burell and Morgan (1979) point out that mutual cooperation within and between different disciplines is anything but simple because of the mutual exclusiveness of particular paradigms. In this paper, "paradigm" is understood as a conceptual and methodological core that is common to all members of a particular scientific community or school members (Ule, 1992; Sušjan, 1993). Members of a particular paradigm share a system of education and the same view of solving relevant problems. Kuhn (1998) maintains that paradigms are incompatible and incommensurable because they rely on different assumptions; thus, they are in a state of "paradigmatic war" (Reed, 1994).

Ward (1972) and Johnson (1983) stress that economics is "ruled today" by the neoclassical paradigm. Modern neoclassical theory centers its attention on the workings of the market, prices, and equilibria, which compels heavy use of mathematics and objectification of knowledge. Compared to other theories, economic theory has developed a fairly straightforward and closed system based on rationality, equilibrium, and methodological individualism. The starting point is the concept of rationality which becomes the standard tool of analysis. The neoclassical school "exerts" a high level of control over the scientists through their education and financing, and through the methodology they employ. On the one hand, use of such scientific language within the neoclassical paradigm reduces the diversity of methodological approaches and opinions within economic theory; on the other hand, it impedes better cooperation with other scientific communities. Rigorous methodology renders it adverse to both internal pluralism within its own scientific community, and external pluralism in the sense of more intense cooperation with other scientific disciplines.

Neoclassical economics often simply ignored any critique pointing out its unwillingness to work more profoundly with other scientific disciplines, and rather than acknowledging its weakness, developed a strong conviction of its own power. Desire for universal dominance and validity led to ever stronger "intrusions" of economics into other fields. The economic imperialism of the neoclassical school is manifest both internally within the economic community and externally in its drive to conquer other fields. Adopting principle of competitive advantage, (neoclassical) economics developed its competitive advantages relative to other social sciences for the following three reasons.

First, objectification of knowledge at the epistemic level allows a systematic and transparent organization of theoretical knowledge; thus, the "system of rationality" is extended to the very theory of science as well (Kovač, 2001). Rational science is thus connected with the economic models of rational behaviour of economic agents. Secondly, divisions and institutionalization of science within particular scientific communities created the circumstances for the venture of economics into other, traditionally non-economic fields. Neoclassical economic theory argues that economic rationality can be applied to all fields of human life where scarce resources and problems of choice appear (Becker, 1976). Becker (1976, 1993) advocates the application of economic rationality to family, human capital and crime. Stigler (1984) lists four fields of economic imperialism: economic analysis of politics, economic analysis of sociological structures, economic history and economic analysis of law. And thirdly, the neoclassical paradigm succeeded in monopolizing the market for science in terms of publication and in their influence on the adoption of key decisions in the society. The unity of introductory economics textbooks illustrates the high level of homogeneity of the neoclassical school (McKinley & Mone, 1999).

Economics has the leading role among social sciences and thus has been dubbed the "queen" of social sciences. Use of rigorous language expresses the desire for universal application of neoclassical approaches even in traditionally non-economic fields. With such "uninvited" advances into other scientific fields, economics clearly and unambiguously presents its lack of interest in more interdisciplinary approaches that would allow deeper understanding of today's problems. With its scientific language, methodological apparatus, and uncompromising forays into other fields, neoclassical economics is effectively destroying the foundations for more fruitful cooperation with other scientific disciplines.

4. Postmodern Holism and Pluralism

Post-modernism encourages deeper cooperation between and within scientific communities since the key goal of post-modernism is to move beyond paradigmatic approaches (Johnson, 1983; Hassard, 1993). In the post-modern open society, we encounter scientific languages of various scientific communities and schools (Hassard, 1993; Cooper & Burell, 1988). A higher level of mutual communication, tolerance, cooperation, and competition between and within different scientific communities should be developed. Only such an interactive process will allow understanding and resolving emerging problems and puzzles (Cooper & Burell, 1988; Pheby, 1988).

No approach would be either privileged or à priori eliminated (Feyerabend, 1999). For example, we do not know whether the present crisis is best understood by orthodox (neoclassical) or heterodox economic theories (e.g. institutional, Marxian). It is simply impossible to establish since there is no absolute set of appraisal criteria by which to judge the theories (incommensurability problem). Thus, an economist could use approaches that would, in his own belief, be best suited for a particular problem and situation. This would enable a more democratic debate within the economic discipline and at the same time contribute significantly to better understanding of the real economy since decision-makers would have a range of different policy scenarios at their disposal.

Thus, the key goal in the education of today's economists should be to move beyond the paradigmatic approaches in economics and to promote deeper cooperation between different scientific disciplines. I also strongly believe that only such an education process will foster understanding of the emerging problems and contribute meaningfully to their solutions. I believe that the urge for a deeper understanding of today's problems demands an education approach which would leave generations of future scholars more familiar with different schools of thought within economics and with other scientific disciplines. The teaching of economics should include more readings of economic classics as well as relevant topics from other scientific disciplines.

A more pluralistic and holistic education would undoubtedly increase the students' capacity for critical, controversial and original thinking in order to avoid the mistakes of their teachers. The aim of the next section is to show whether debate as an educational method is suitable for helping us to achieve these goals.

5. Debate “Pro et Contra”

McCloskey (1983, 1994) argues that economists’ genuine “workaday” rhetoric, the way they argue inside their heads or their seminar rooms, largely diverges from the “official” rhetoric based on statistical tests and regressions. Thus, economists should focus more on their workaday rhetoric, because they will then better know why they agree or disagree by using metaphors, the relevance of historical precedents, the persuasiveness of introspections, the power of authority, the charm of speaker and the claims of morality (McCloskey, 1994). Rhetoric is a disciplined conversation and by "rhetoric" it does not meant a verbal shell game, as in "empty rhetoric" (McCloskey, 1994).

The rhetoric approach has roots in the classical rhetoric of the ancient Greeks. The contemporary approach is similar in forms and methods of argument, but it now applies also to the practice of science. The Greeks were focused mainly on speech-making; however, contemporary approaches are focused on dialogues between scientists (or students in the class). The rhetoric approach is thus a social framework in terms of how it produces and disseminates new ideas and arguments (Boumans & Davis, 2010). On the other hand, it is also a framework in which we are persuaded within the framework of these structures and exposed to direct critique and persuasion of others. Snider and Schnurer (2006) argue that economic issues are well suited for such a debate.

I believe that the ability to teach students through a more interactive debate process to develop new thoughts and to explore new theoretical ideas within and beyond economics in order to better understand and solve real world problems should be the key goals in education of every teacher. I firmly believe that debate “pro et contra” as an educational method can help us tremendously in achieving these goals. Debate is an equitably structured rhetorical event in the class about some topic of interest, with opposing advocates alternating before a decision-making body. A debate is structured, with established communication periods with a beginning and an end (Snider, Schnurer, 2006).

Among a wide variety of debate formats, I decided to employ the format debate “in vivo” by two opposite teams plus a public assembly. Each two weeks I appointed two teams and gave reading assignments (posted on the course website) for the following class. The teams were required to prepare a public discussion (debate) on the selected topic to be presented in the classroom. In the debate they sought to persuade their opponents and the rest of the students in the class. Team A advocated the thesis and Team B took the opposing side. Both teams presented their arguments during a public debate following a previously defined protocol.

Each team wrote a written report highlighting the key arguments and positions for the debate. The summary form was submitted on the forms downloadable from the course website. This written summary was a prerequisite for taking part in the debate and was the basis for the final assessment of each team's work. Students in each group were obliged to send to me as the professor emailed written reports at least one week before they presented their arguments in the class. I gave them the feedback in order to improve their argumentation in the following class debate.

Teams A and B competed in a public debate ("pro et contra"). Team A advocated the thesis (the government side) and Team B took the opposing side (the opposition). The teams presented their arguments during a public debate following a previously defined protocol. The starting point for the discussion between the two teams was the initial thesis. Based on the materials, each team delivered two key arguments (equal to the number of team members) or points of emphasis. These arguments were devised so as to form a coherent whole and allow the strategic promotion of a central idea.

The class discussion followed the rules of a procedure. The first speaker of the advocating (government) side (Team A) began by presenting the central idea and the team's first argument (5 minutes). Afterwards began the cross examination, during which all members of the opposing side questioned the first speaker of the advocating team (at least 1 question by each student) (5 minutes). The first speaker of the opposing side (Team B) proposed the first argument of the opposing team (Team B) (5 minutes) and afterwards a cross examination by all members of the advocating side followed (at least 1 question by each student) (5 minutes). The last stage was a public forum discussion involving all students and professor (5-7 minutes). The number of rounds was equal to the number of students in one team. If a team member was absent for any reason, the other team members had to find a replacement or present all arguments and cross examinations alone.

Cross examination allowed the two teams to challenge the opponents, request clarification of arguments and refute their claims. Questions were voiced by both members of the team, who took part equivalently in the argumentation. The forum with other students in the class, taking place at the end of the discussion, had a similar form. Each speaker waited for the professor's permission to speak, then stood up to speak. The Professor intervened if the rules were not abided by. The professor merely directed the progress and succession of the discussants, opened and closed the successive rounds, selected the following speaker and summed up the conclusion.

After the end of the debate, the class selected the winning team by raising hands. The winning team received a score bonus. The entire debate competition took up to 60-75 minutes. Average times were indicated, and the moderator could extend the debate when appropriate, or cut it short. Thirty seconds before the expiration of the time available to the speaker, the timekeeper knocked on the desk to indicate that the exposition should be drawn to a close. The professor assessed the discussion, the participation of other students, and the written report. Each team member taking part in one debate competition might score a maximum of 20 points (percent) towards the final grade.

When preparing the discussion, the teams used, in addition to the core reading material, other resources (the scientific articles, books etc.). Each team member submitted to the professor the written reports/summaries for the debate competition, in writing. The introduction to the debate and the conclusion are considered teamwork, while arguments 1 and 2 etc. are the work of respective individual team members. The report also included a definition of five terms occurring in the article or related to the philosophy of science topic. All other students (not actively engaged in the debate group) had to write their weekly reports in which they argued their positions regarding the thesis (maximum one page). Weekly reports and participation in the class are worth an additional 20% of the final grade, while the written exam is worth 60% of the final grade.

6. Communities of Teachers and PhD Students in a Mutual Learning Process – A Qualitative Study

Debate is an equitably structured rhetorical event in the class about some topic of interest, with opposing advocates alternating before a decision-making body. Debate "pro et contra" was conducted in the PhD class at the Faculty of Economics, University of Ljubljana, Slovenia in a group of 28 students. There were 5 debate assignments in five weeks.

The qualitative analysis is based on a survey of all students in the class. For a higher level of objectivity, all students were requested to fill out a questionnaire before taking the final exam. The questionnaire is divided into two parts (Evaluation of the course content, Evaluation of instructor). We are mainly interested in the first part of the questionnaire, where a combination of open- and closed-ended questions was used in order to allow students to evaluate in any way they wanted the quality of "pro et contra" debate. Open-ended questions enable students to better express the quality of the classroom debate. Here are presented several quotations from the questionnaire in order to show how students recognized the importance, benefits and usefulness of debate.

I believe that debate encourages students to use different theories in analysing a particular problem. Looking at the same problem from different perspectives improves the student's understanding of the problem. Students pointed out the advantages of a more holistic and pluralistic approach:

- Student No. 1: Debate enables us to broaden our views on the same topic.

- Student No. 2: I liked openness to all streams of economic thought.
- Student No. 3: In the debate we are able to research the same thing from different aspects.

Particular schools and scientific communities too often teach passive acceptance of their ideas. Pluralism within and beyond economics consequently encourages students to think more critically and originally. I strongly believe that debate "pro et contra" helps student to practice critical thinking. Many students noticed this aspect as well by saying:

- Student No. 1: The most positive segment in the debate is that it fosters critical thinking.
- Student No. 2: Student participation and critical thinking are strongly encouraged in debates.
- Student No. 3: In the course students were inspired to participate and think critically.
- Student No. 4: Debate promotes critical thinking even if a student doesn't share the same view.
- Student No. 5: Debate covers very interesting topics and promotes critical thinking.
- Student No. 6: The educational system usually works differently (not much of critical thinking is welcome) so this debate approach was a nice surprise.

Students got constructive feedback in a debate from other students and the professor as well. Several students pointed out strong engagement in a team's work. Thus, professor and students are mutually engaged in the cooperative learning process. Students point out these aspects of social learning by saying:

- Student No. 1: Good interaction between students and professor provoke us to think critically and to be engaged in the joint learning process.
- Student No. 2: The debate approach requires ex-ante preparation however it proves to be useful for the overall learning process.
- Student No. 3: The topics for debates were nicely chosen and professor and student feedbacks were very useful for me.
- Student No. 4: The professor stimulates the student's class participation and helps us greatly in preparing for the debates.
- Student No. 5: Debaters learn not only to compete with others but also to help each other by accomplishing cooperatively the tasks they have been assigned.

It seems that students greatly prefer debate as an educational method over the traditional ex-cathedra teaching in the class. In the questionnaire one of the questions was "Should the debate pro et contra as a teaching method be changed to classical ex-cathedra teaching?"

- Student No. 1: Debate forces you to put your heart, soul and mind into the matter.

- Student No. 2: We have sufficient ex-cathedra teaching in other courses and there is a lot of value added from the debate approach.
- Student No. 3: Even if some students do not want to be in a spotlight, it's useful for them.
- Student No. 4: Debate is highly stimulating, requires people to speak publicly and to be prepared for every class.

The possible disadvantage of such a pluralistic and holistic approach is that it could increase the confusion among students. Pluralism may lead to intellectual nihilism by giving students the right to assume whatever they feel happy with is right. A few students emphasized these risks by stating:

- Student No. 1: At the beginning of the debate different positions should be pointed out more clearly so students would be less confused.
- Student No. 2: I think it would have been easier for me if I have heard professor's lectures on a certain topic before I had to read all the materials. Sometimes during the literature review I had no idea what was going on and which theory is more important.
- Student No. 3: In the debate "pro et contra" we are not always sure what is expected at the end from us.

A variety of findings emerged from the questionnaire. Several quotations show that students recognized the importance, benefits and usefulness of debate as an educational method. The vast majority of students expressed a preference for looking on emerging problems from different theoretical perspectives. Also debates enabled students to think more critically and originally and so they strongly prefer debate as an educational method over the traditional ex-cathedra teaching. The negative side of such a lively debate in the class could be that it can increase some confusion among students. I believe that classroom debate as an educational method can be used for promoting more pluralism and holism in education of today's economists in order to better resolve today's problems.

Debate also enables students and professors to be more mutually engaged in the two-way learning process. Through debate "pro et contra" the roles of the students and teachers have switched and changed, with students increasingly becoming a subject of the educational process and teachers becoming, more than in a traditional role, moderators thereof.

I believe that knowledge is necessarily dispersed and not given completely to anyone since it is embedded not only in a traditional one-way transfer of knowledge from teachers to students but also in relationships among students and professor. I believe that without debate, students can never appropriate entirely new knowledge because some is necessarily dispersed and not given completely to anyone. Through debate, knowledge is increasingly spilling over to other users of knowledge since it is embedded not only in books but also in debates, teamwork and class conversations. As a result, the debate process can become an important trigger of new knowledge creation and a mutual learning process through which knowledge becomes less a private and more a public good.

7. The Role of Technology in "Pro et Contra" Debate

The role of technology in pro et contra debate is not limited only to reading assignments on the course website for the following weekly PhD class. Beside "in vivo" class debate for the PhD students I had also conducted a "virtual class debate" for another course (macroeconomics, undergraduate).

A substantially larger class of 500 (less demanding) students I divided into groups of 35-45 students per each group. The students in a group got a digital identity to get access to the course materials and to the virtual debate room. Administrator fostered the virtual debate and controlled the content, list of participants and grading. Our experiences show it was a less structured conversation among the participants in the particular group. It seems that in comparison to the "in vivo" debate the "virtual" debate was less in depth, a less passionate and mutually engaged learning process.

However, on the other side the "virtual" debate helped us to extend the period of the interactive work. The main motive for the introduction of the "virtual" debate was possibility of the direct engagement of the students after "in vivo" debate was concluded. Accessing the "virtual" debate before and after the "in vivo" class debate enables students to be engaged more time on the particular topic of their interest. The value added of the "virtual" debate is that students can work interactively with other students for a substantially longer period. After the "virtual" debate is concluded the participants have a read only access. The starting and closing dates for the "virtual" debate have to be defined in advance. Upgrading the "in vivo" debate by a "virtual" one leads us to three lifecycles phases of the debate as an educational method: preparation period for the debate, "in vivo" debate in the class and "virtual" debate afterwards.

8. Conclusion

It is my deep belief that reality should have a stronger influence on the education of economists, especially when a growing divergence between reality and theory can no longer be denied. The education of today's economists is based mainly on the neoclassical approach, which has developed a fairly straightforward and closed system based on rationality, equilibrium, and methodological individualism. The unity of introductory textbooks and academic programs illustrates the high level of domination of the neoclassical school in economics. Its dominant position is mainly perpetuated through the education process as strict methodological rules have become an ideal for the majority of contemporary economists. Such domination of the neoclassical paradigm in economics and in the broad framework of social sciences leads to partial analyses and localized worlds. Because of its self-sufficiency, economic theory has lost the capacity to take an anthropocentric view of the world, which has led to the social irrelevance of the neoclassical paradigm.

I believe that the origins of the social irrelevance of the neoclassical paradigm can be primarily found in the education system. The key goal in the education of today's economists should be to move beyond the paradigmatic approaches in economics and to promote deeper cooperation between different scientific disciplines in order to foster understanding of today's problems and to contribute meaningfully to their solutions.

I firmly believe that debate "pro et contra" as an educational method can help us tremendously in achieving these goals. Debate is an equitably structured rhetorical event in the class about some topic of interest, with opposing advocates alternating before a decision-making body.

Our qualitative study shows that a classroom debate can be a highly efficient educational method for promoting more pluralism and holism in the education of today's economists. The vast majority of students expressed a preference for looking on problems from different perspectives. Also, debates enabled students to think more critically and originally and so they strongly prefer debate as an educational method over the traditional ex-cathedra teaching. The negative side of such a lively debate in the class could be that it can increase some confusion among students.

Debate also enables students and professors to be more mutually engaged in the two-way learning process. Through interactive debate "pro et contra", the roles of the students and teachers have switched, with students increasingly becoming a subject of the educational process and teachers becoming more moderators. Such a change in pedagogical practice introduces a more pluralistic concept and more interactive process of social learning. The debate "pro et contra" becomes a social framework in terms of how it produces new ideas and arguments through greater student engagement than in a traditional one-way transfer of knowledge from teachers to students.

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THE EFFECTIVENESS OF PEER ASSESSMENT IN THE FLIPPED CLASSROOM

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Abstract

The flipped classroom pedagogy has been promoted to encourage students to learn at their own pace outside the classroom and with the absence of teachers. Valuable in-class time can thus be freed up for students to deepen their understanding of the content. However, learning at home can promote a lackadaisical learning environment. Student learning relies heavily on learning motivation. To address this motivational challenge, a peer assessment component was deliberately integrated into the flipped classroom pedagogy in this study. Preliminary results suggest that the students demonstrated a good attitude in the pre-lesson peer assessment process, and they were satisfied with the peer assessment activity.

Keywords: Peer Assessment, Flipped Classroom, Assessment for Learning, Peer Feedback, Interaction

Introduction

In recent years, higher education standards have emphasized the shift from an instructor-centered educational model to student-centered learning. Teachers, instead of being the "sage on the stage", function as a "guide on the side" to facilitate students' collaborative active engagement with the learning resources in their knowledge construction endeavor (King, 1993). The advance in digital technologies provides many opportunities for students to learn in a more dynamic and innovative way. Therefore, there is a growing need to rethink and redesign the traditional lecture-based course model for the 21st-century classroom. One such pedagogy is the flipped classroom, which consists of a combination of pre-class and in-class learning activities. While there are advantages in using the flipped classroom pedagogy, it is not without challenges in its implementation. One of the major challenges comes from the attitudes of students learning outside the classroom. Learning effectiveness will decline if the student has a low level of self-regulated ability (Akcayir & Akcayir, 2018). In order to address the challenge, a peer assessment component, with the aim to promote students' interaction and learning satisfaction, was deliberately integrated into the design of the flipped classroom pedagogy in this study. This paper aims to report the pedagogical design of integrating a peer assessment component in the flipped classroom pedagogy and its effectiveness in improving student attitudes towards learning.

Literature Review

This section gives an introduction to the flipped classroom pedagogy and highlights the challenge of unsatisfactory student attitudes in pre-lesson learning. It is followed by a discussion of peer assessment in promoting student attitude. The research question is stated at the end of this section.

Advantages and Challenges of Flipped Classroom Pedagogy

The flipped classroom pedagogy is often referred to as "reverse instruction", "blended learning", "inverted classroom" or "24/7 classroom" (Bergmann & Sams, 2012). While a widely agreed model has not existed (Tucker, 2012), the essence of the flipped classroom approach is for instruction that used to occur in class to be accessed at home in advance of class. The valuable in-class time can then be freed up for students to participate in higher-order problem solving and collaborative learning tasks under the guidance of a teacher to enhance the effectiveness of learning (Kim, Kim, Khera, & Getman, 2014; Lage, Platt, & Treglia, 2000; Tucker, 2012).

The flipped classroom pedagogy has been widely adopted across various disciplines in higher education. Examples of applying this pedagogy can be found in software engineering (Gannod, Burge, & Helmick, 2008), nursing (Missildine, Fountain, Summers, & Gosselin, 2013), nutrition (Gilboy, Heinerichs, & Pazzaglia, 2014), history (Gaughan, 2014), biology (Stone, 2012), and language education (Hung, 2015). There are many benefits of utilizing the flipped model of teaching and learning. First, this approach offers a flexible mode of learning. Since the learning materials can be accessed online, students have the autonomy to take control of their learning in their own space, and at their own pace. In flipped classrooms, students are generally required to watch assigned online videos before coming to classes, where they participate in group activities and discuss problems or misconceptions. After the class, they are encouraged to review the online learning materials provided by the teacher and other resources on demand in order to reinforce their understanding of the acquired knowledge. It also fosters students' self-regulation competence (Lai & Hwang, 2016), digital literacy skills and lifelong learning skills required in the 21st century (Ng, 2015). Second, by having students coming to class prepared, instructors can use class time more effectively and creatively to provide multiple opportunities for students to collaborate and apply what they have learned. Third, a number of studies have shown the improvement in student learning outcomes, assignment performance, motivation, levels of student engagement, and satisfaction with the learning in the classroom by the application of the flipped classroom pedagogy (Mason, Shuman, & Cook, 2013; McLaughlin et al., 2013; Stone, 2012). Fourth, the flipped classroom model provides more capacity in class to develop students' generic skills such as critical thinking skills, problem-solving skills (Mason et al., 2013), creative thinking skills (Al-Zahrani, 2015), and collaborative learning skills (Strayer, 2012).

The flipped classroom can take many forms. One common strategy is termed 'just-in-time teaching' (Novak, Patterson, Gavrin, & Christian, 1999). It is a web-based pre-class warm-up activity where students complete an electronic assignment (e.g., reading, watching lecture videos, doing worksheets or exercises) and then submit their responses online before the class. By doing so, teachers are given just enough time to evaluate students' learning progress and to incorporate insight gained from the responses into the upcoming lesson (Novak et al., 1999). Therefore, in-class activities are tailored to address specific problems and cater to individual learning needs.

Although the flipped classroom pedagogy brings many benefits to student learning, it is not without challenges in its implementation. A comprehensive review of the challenges related to the flipped classroom pedagogy can be found in the studies by Lo and Hew (2017), and Akcayir and Akcayir (2018). Among the related challenges, students' unsatisfactory attitudes, such as paying less efforts, in the pre-lesson activity is consistently highlighted. Learning is an active, generative, and effortful process, and good learning requires students to adopt a mindful approach. However, students may not always behave in this ideal way. The learning outside the classroom driven by students themselves promotes a lackadaisical learning environment. This mode of learning relies heavily on students' self-motivation. Students with a low level of motivation may get less done (Du, Fu, & Wang, 2014). Chen (2016) reported that some students in his study did not complete pre-lesson activities and instead go to the class unprepared, which negatively affected subsequent in-class collaborative activities. Students' attitudes towards pre-lesson learning is, therefore, considered a critical factor for the success of the flipped classroom pedagogy.

Peer Assessment Promotes Positive Attitude

Assessment for learning has been advocated in the last few decades, especially after the extensive literature review conducted by Black and Wiliam (1998) to confirm its beneficial impacts on learning. Assessment has been identified as a powerful aid to engage students into a more in-depth learning process and transform them into reflective practitioners (Ng, 2016). Among the various methods for implementing assessment for learning, peer assessment has been particularly encouraged in the design of teaching and learning in higher education (Ng, Xie, & Wang, 2018; Ng, 2013; Ng, 2012). Peer assessment is able to improve students' learning to learn skills, social skills, promote reflection and self-assessment, and enhance meta-cognition of self-awareness (Topping, 2009; Topping, 1998). In the affective aspect, peer assessment that involves students in an active learning process enables students to develop a greater sense of ownership and responsibility in their learning and evoke a higher level of learning motivation (Topping, 1998).

Interaction is an important element of peer assessment. As suggested by Moore and Kearsley (2005), learner-learner interaction can be achieved in groups which includes both within-group and between-group interactions. It can also be done on an individual basis, where a student interacts with others in the learning community. With the advancement of communication technologies, it is now possible for students to interact in online environments. Students usually find peer interactions stimulating and motivating. Inter-learner discussions are also considered to be highly valuable in helping students to evaluate learning content (Moore & Kearsley, 2005). In the literature, the importance of interaction in teaching and learning has been suggested (Swan, 2002). Interactions have been recognized as one of the most important components of learning experiences in education (Vygotsky, 1978). Purposeful interaction in specific and predetermined ways can enhance students' knowledge and skills (Ritchie & Hoffman, 1997). Research has demonstrated that active discussion among course participants significantly influences students' satisfaction and perceived learning in a positive way (Swan, 2001). Similarly, Rust (2007) stressed that dialogues between students are valuable to the learning process. Jung, Choi, Lim, and Leem (2002) also suggested that collaborative interactions with peers are important in enhancing learning and active participation in online discussions.

Given that peer assessment is known to enhance students' positive attitude, a peer assessment component was deliberately inserted into this study during the implementation of the flipped classroom pedagogy. This study aimed to explore the question "What is the effectiveness of integrating a peer assessment component to improve students' learning attitude in the flipped classroom pedagogy?" The following section elaborates the method of this study.

Methods

This section describes the procedure of the study and how data were collected and analyzed.

Procedure

In this study, the researchers' intention was to understand the phenomenon of the learning process in its natural setting. The case study approach to qualitative research was applied to explore the research question (Punch, 2011). The researchers were teacher-trainers in a teacher-training institute in Hong Kong. This study was conducted in a Master of Arts in Mathematics and Pedagogy Programme. The participants were selected using a convenience sampling approach. A total of 20 students taking the course entitled Instructional Design in Mathematics were invited to participate in this study. Three of them obtained their bachelor's degree from universities in Hong Kong while the rest from universities in Mainland China. Seven groups with two to three students per group were formed randomly at the beginning of the course for a subsequent peer assessment activity in the flipped classroom.

Before the lesson, each group was assigned to watch an online video of secondary school mathematics. The topics of the video include Pythagoras' Theorem, Remainder Theorem, solving quadratic formula, the graph of exponential function, the angle of elevation and depression, and usage of Pythagorean trigonometric identity. Each student in a group was required to review the assigned video and design five to six short questions about the video that show understanding of the key concepts introduced in the video. They were informed that the quality of their questions would be assessed by their peers. During the subsequent lesson, the members in each group discussed all suggested questions and agreed upon five to six questions that demonstrated understanding of the key concepts in the video.

In the week before the second lesson, a video link, together with the agreed upon questions of each group, was sent to students of two other groups. Each student was required to assess the quality of the questions designed by their peers with regard to content and presentation. They were asked to provide constructive feedback. In this design, each group received five to six sets of individual responses from the members of two other groups. The researchers collected all the feedback and sent it back to the original group for further in-class discussions. During the second lesson, each group discussed the collected feedback and finalized a set of questions for the video assigned to their group. In the next lesson, each group was then required to embed the finalized questions into the video using the edpuzzle platform. At the end of the lesson, the students were invited to express their opinions on the peer assessment component using a questionnaire adapted from the study conducted by Chu, Hwang, Tsai, and Judy (2010).

Data Analysis

In this study, data were collected in the peer assessment process and at the end of the pedagogical intervention, analyzed to make sense of students' learning attitude. During the process, an individual student was required to provide feedback to the peers. As suggested by Garrison and Innes (2005), it is the quality of the feedback provided by students in the peer assessment process that can more reliably reflect students' attitudes in the process of inquiry. It is reasonable to believe that students who adopt a serious attitude in the peer assessment process will produce more high-quality feedback. An important criterion of high-quality feedback is whether it is specific or not (Gielen, Peeters, Dochy, Onghena, & Struyven, 2010; Nelson & Schunn, 2009). It includes providing the location of and identifying the problem as well as offering a solution. Feedback in this format can be categorized as "Specific Feedback". On some occasions, the contents of a draft assignment may be incomplete but not incorrect. Advisory feedback, which is more indirect, is considered appropriate as a kind of scaffolding for learning (Tseng & Tsai, 2007). This type of feedback is categorized as "Suggestive Feedback". Another two categories of feedback advocated by researchers are "Summarizing Feedback" and "Reinforcing Feedback". Summarizing feedback refers to summary statements which condense portions of an essay or the whole essay (Nelson & Schunn, 2009). Reinforcing feedback is given as a kind of praise when the student does it properly or correctly (Tseng & Tsai, 2007). However, since feedback is valuable only if it promotes subsequent improvement, reinforcing feedback or summarizing feedback can only be considered useful if it is followed by specific feedback or suggestive feedback which lets students know how to improve. This kind of feedback can be regarded as "Mitigative Feedback" which makes the criticisms less abrasive. Therefore, the researchers analyzed the feedback provided by the students to determine the extent to which it could be categorized as high-quality Specific Feedback, Suggestive Feedback, and Mitigative Feedback, therefore identifying the students' attitudes in their pre-lesson learning process. Apart from analyzing students' feedback, the data collected by the questionnaire at the end of the pedagogical intervention were analyzed using descriptive statistical methods to review students' overall satisfaction on the peer assessment component in the flipped classroom pedagogy.

Results

In the process of peer assessment of the design questions, a total of 217 comments were provided. The number of comments in the categories of specific feedback, suggestive feedback, and mitigative feedback were 83 (38%), 18 (8%), and 41 (19%), respectively. In other words, 65% of comments given by the participants during the pre-lesson peer assessment activity were regarded as high-quality. Apart from that, there were 63 (29%) comments in the form of low-quality reinforcing feedback. Another 12 (6%) comments were found to be vague in the meaning. Examples of different categories of feedback are listed in Table 1.

Table 1
Examples of feedback provided by the students in peer assessment

Feedback Category	Topic of Video	Designed Question of the Assigned Video	Peer Comment
Specific Feedback	Pythagoras' Theorem	Please guess the condition for Pythagoras' Theorem.	Do not use "guess". I cannot guess the condition before I recognize this theorem.
Suggestive Feedback	Graph of Exponential Function	How many points are appropriate to sketch the graph?	I think we should review the steps of drawing a general graph of a function, then consider how many points are appropriate to sketch the graph
Mitigative Feedback	Solving Quadratic Formula	State the general form of method of taking square roots.	Good question to make sure that students know the form of the quadratic equations when using the method of taking square roots. You can also review the two steps when using the method of taking square roots before you set another example for students to practice.
Reinforcing Feedback	Pythagoras Theorem	How to use Pythagoras' Theorem to get out of the cave?	This question is good because it has the calculation.

At the end of the last lesson, the students were invited to express their comments on the peer assessment component using a questionnaire with a Likert 5-point response scale in which 5 indicates Strongly Agree and 1 indicates Strongly Disagree. The results are listed in Table 2.

Table 2
Students' opinions on the peer assessment component in the flipped classroom pedagogy

Question	Mean
1. The mission of this learning activity makes me better understand how to identify and classify the features of the target learning objects.	4.8
2. Although the mission of this learning activity might not easy to complete, it was easy to understand the way of learning.	4.8
3. Learning with this peer assessment approach is more challenging and interesting than learning with the traditional direct teaching approach.	5
4. I had new findings or knowledge about the target learning objects owing to the use of this peer assessment approach to learn.	4.9
5. I have tried new ways of thinking styles to learn owing to the use of this peer assessment approach.	4.7
6. The guidance provided by the peer assessment approach is helpful to me in learning how to identify the features of the target learning objects.	5
7. The guidance provided by this peer assessment approach is helpful to me in observing the differences within the target learning objects.	5
8. When using this peer assessment approach, I learned how to observe the target learning objects from new perspectives.	4.9

Discussion and Conclusions

The flipped classroom pedagogy is becoming more prevalent in teaching and learning, especially in higher education. A core component of this pedagogy is that students are asked to carry out self-study outside the classroom before the lesson. Research highlights that students' unsatisfactory attitude in self-study outside the classroom is a critical challenge (Akcayir & Akcayir, 2018; Lo & Hew, 2017). Self-learning without the guidance of a teacher promotes a lackadaisical learning attitude (Du et al., 2014). The effectiveness of learning to a great extent hinge on students' self-motivation. A student with low motivation may not follow the instructions from the teacher to work on the pre-lesson activity and it may adversely affect the effectiveness of the flipped classroom pedagogy (Chen, 2016). This study attempted to integrate a peer assessment component in the process of flipped classroom pedagogy to enhance students' positive learning attitude. Quite positive results were obtained from this study. A total of 65% of peer feedback given by the students in the pre-lesson activity was in the categories of high-quality specific feedback, suggestive feedback, and mitigative feedback. It reflects that the students completed the pre-lesson activity with a good attitude since research has confirmed that students who adopt a serious attitude in the peer assessment process will produce more high-quality feedback (Garrison & Innes, 2005). In order to provide triangulation of results, a questionnaire was used to explore the students' overall satisfaction on the peer assessment component of the teaching method. As shown in Table 2, the mean scores ranged from 4.7 to 5. This suggests that the students were very satisfied with the integration of a peer assessment component in the flipped classroom pedagogy. In particular, they considered learning with this peer assessment approach as more challenging and interesting than learning with the traditional direct-teaching approach. The guidance provided by the peer assessment approach was helpful in learning how to identify the features of the target learning objectives. This result further strengthens that peer interaction promotes active learning and overall satisfaction (Moore & Kearsley, 2005; Swan, 2001; Jung et al., 2002). However, we remain cautious about the results due to the limitation of this study: there was no control group included for comparison and the sample size was relatively small.

Even though research has confirmed the beneficial effects of the flipped classroom pedagogy in student learning, it is important to address the challenges in its implementation. To secure the effectiveness of the flipped classroom pedagogy, educational practitioners are recommended to include a peer assessment component, such as the design in this study, to promote students' positive attitude during their self-study outside the classroom. This study contributed to the field by suggesting the method of using assessment for learning to enhance learning effectiveness for future reference.

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THE IMPACT OF BLENDED LEARNING ON STUDENT PERFORMANCE IN AN INTENSIVE BLOCK MODE TEACHING SETTING

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Abstract

In an attempt to transform the first-year student experience, Victoria University adopted a Block Teaching Model. Under this 3.5 weeks-long intensive setting for a physics unit, face-to-face sessions were complemented with various blended learning initiatives, including interactive HTML5 (H5P) rich video presentations, an open-access electronic textbook, and online simulations and quizzes. A strong correlation between student performance in assessment tasks and participation in corresponding blended learning activities was discovered. Similar findings were obtained by analysing gain in student conceptual understanding. These results clearly showcase how technology enabled learning can enhance student performance in an intensive block mode teaching setting.

Introduction

Recent shifts in tertiary education have resulted in a significant increase in the participation of students undertaking university studies. While this phenomenon has created studying opportunities for various normally disadvantaged social groups (i.e., high school leavers, mature age students, etc.), it has also led to an ever-increasing degree of diversity among the student cohort across the Western world and beyond (Biggs, 2011). Recent research has also shown that students entering Australian universities with low tertiary admission ranks (ATAR) “continue to be less prepared, less able to cope with study, less academically engaged than their peers, and are at greater risk of attrition” (Baik, Naylor, Arkoudis, & Dabrowski, 2019).

In an attempt to address this issue and in the process, to provide a better learning experience for students while also improving student retention and satisfaction, Victoria University (VU) has recently adopted an innovative mode of teaching (McCluskey, 2018). The Block Model is designed so that students are able to focus on one subject comprising eleven classes over a three and half week “Block”. Underlying this design is an expectation that studying just one subject, via an intensive, face-to-face block in a relatively small class of approximately 30, will allow students to achieve a better conceptual and practical understanding of the investigated topics. Within such a class, students establish a much more meaningful relationship with their peers and educators (Dodd, 2018). Intensive teaching formats create opportunities for a range of different active learning opportunities such as peer learning (PL) or interactive engagement (IE), the benefits of which are well documented in literature (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Hake, 2002; Wieman, 2017). This study explores how a blended learning approach can influence student performance in a first year physics unit under VU's recently adopted block mode of teaching.

Literature Review

Decades of research in science education has shown that traditional lecture-based instruction fails to promote deep holistic learning experiences. Surface learners tend to focus predominantly on memorizing basic physics concepts or following a set of defined procedures while using formulas. This approach obstructs development of their critical thinking and problem-solving skills (Redish, Hammer, & Elby, 2001). A student who readily accepts information provided through authoritative sources (teacher, textbooks) without question often comes to believe that physics knowledge consists largely of an unrelated collection of incontestable facts and formulae. Such students tend to memorise physics problems and formulas for assessment purposes and are even capable of solving problems they have previously seen; however, the main drawback of such a learning approach is that students cannot solve problems they have not encountered before, even if trivial changes are made to the problem. Research shows that although many students succeed in passing physics courses, few students retain a deep understanding of the core physics concepts after they complete their course (Redish et al., 2001). Given the drawbacks of surface learning approaches, it has been proposed that an active learning approach based on the principles of learner-centred teaching approaches and interactive engagement can facilitate the construction of deep and meaningful knowledge (Drinkwater et al., 2014). Numerous studies have shown that students develop deep understanding when they are actively engaged in the learning process and are provided opportunities to demonstrate their learning with immediate and meaningful feedback (Biggs, 2011; Wieman, 2017).

Blended learning is a relatively new approach to university instruction that combines face-to-face (F2F) instruction with the delivery of a variety of evidence based online learning activities without reducing F2F classroom contact hours (Dziuban, Hartman, Cavanagh, & Moskal, 2011). The key advantage of blended learning is that it maximises the class time dedicated to problem solving and students developing a deep conceptual understanding of the content being explored (Bergmann & Sams, 2012). Following the paradigm shift from teacher-centred to learner-centred pedagogies, which are collectively labelled as "constructivism", blended learning is currently a very popular approach to educational frameworks (Means, Toyama, Murphy, & Baki, 2013). Numerous researchers of online education have demonstrated that both the effectiveness and learning outcomes of blended learning are comparable or better when compared to those of traditional F2F classroom environments (Allen & Seaman, 2015;

Larson & Sung, 2009). A few studies have also shown that students in blended learning environments tend to outperform those in F2F classroom environments (Larson & Sung 2009; Means et al., 2013).

Blended learning environments have been shown to produce more effective and measurable learning gains in science-based courses (Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014; Larson & Sung, 2009; Means et al., 2013). However, there is mixed evidence and a lack of rigorous research studies into the effectiveness of different blended learning activities (Means et al., 2013; Zhao & Breslow, 2013) in intensive teaching settings. In our study, we hoped to identify if a correlation exists between student performance in certain assessment tasks and student participation in corresponding blended activities for a Physics unit. The Physics unit in focus (NEF1202 – Engineering Physics 2) is offered to undergraduate engineering and education students under the recently adopted block mode of teaching at VU. Focus was also placed in analysing student conceptual understanding in two thirds of the topics covered in this unit via application of the relevant Brief Electricity and Magnetism Assessment (BEMA) tool.

Unit Design

The primary informing factor when designing this unit was to provide the best possible teaching/learning approach suited to a diverse student cohort, within the time limitations imposed by the block model and the subject's unique specific discipline-based challenges. This was achieved by establishing a balanced variety of tasks that were also directly aligned with carefully crafted learning activities (LAs) based on Millner's types of media (Millner, 2008) suited to phases of Diana Laurillard's conversational framework (Laurillard, 2002).

Under the recently adopted VU Block Model (McCluskey, 2018) a three and half week period consisting of 11 three hour long sessions of F2F teaching is required for the completion of each four week long blocked unit. In the case of science and engineering units, lab activities that provide opportunities to further experiment with the covered topics are integrated in addition to the main 3 hour sessions. Table 1 presents the schedule of the investigated Engineering Physics 2 unit, which focuses on three main areas of undergraduate fundamental Physics; static electricity, magnetism and thermodynamics. A one-hour long session for problem solving is included in Sessions 1, 2, 4, 5, 7, 8, and 10, while three long laboratory experiments consisting of two hours are included in sessions 3, 6 and 9. Also shown in Table 1 are the blended learning types of activities that have been integrated within VUs customised Brightspace Learning Management System – VU Collaborate (VUC) – in this unit. Session 11 is used for final assessment and viewing of students' video presentations.

For every session, students are expected to complete learning activities embedded within a 10 min HTML5 (H5P) rich interactive video as part of a pre-class activity. Each video is designed to introduce the key session concepts, while reinforcing main ideas through the aid of embedded conceptual questions. Students are simply encouraged to watch these videos with no impact on their overall mark as part of a formative assessment strategy. Videos used in this unit were sourced from the Crash Course YouTube channel (CrashCourse, n.d.), while questions were integrated by converting these videos in HTML5 (H5P) rich format. On average 10 questions were generated for each video.

Table 1

*Unit schedule and corresponding in-class and blended activities (noted by *).*

Learning Activities	**Topics & Sessions**										
	Week 1: Static Electricity			**Week 2: Magnetism**			**Week 3: Thermodynamics**			**Week 4: Revision & Videos**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Html5 rich interactive videos *	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Open Access Electronic Textbook *	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Online Simulations, Applet & Demonstrations *	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Problem solving sessions	✓	✓		✓	✓		✓	✓		✓	
Practice Quizzes*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Weekly Long Inquiry Based Activities		✓			✓			✓			
Laboratory Sessions			✓			✓			✓		
3.5 -Week Long Activity – Video Presentation						✓					

These questions were also included in the question library that was built to support a series of online practice quizzes. The question library also included a large group of different versions of the various numerical Physics problems undertaken during the F2F workshops. A randomly generated practice quiz retrieving different combinations of conceptual and numerical problems from the central question bank is formed every time a student attempts a practice quiz. Students are encouraged to undertake these practice quizzes at the end of every session, so that they can reinforce their understanding of the investigated topics. As noted above, relevant numerical based Physics problems would be introduced in the form of supporting tutorial problem sheets in every workshop. Students were able to gain further assistance and practice time within the additional problem solving sessions designed to complement most of the main three long F2F workshops.

During the main workshops, time would normally be utilised discussing the ideas presented in the pre-class videos and clarifying answers to the conceptual questions and mathematical Physics problems. Focus was also placed in introducing each week's inquiry based group (3-4 students per group) activity as well as monitoring student progress while providing feedback and support within the relevant infrastructure. Time was also devoted towards the facilitation of the block-long inquiry based activity, where students had to provide a video script and then generate a 5-10 minute long video presentation in one of the explored concepts (i.e., a presentation on the application of Gauss's Law).
Investigated topics are further explored with the aid of relevant in-class demonstrations or online applets and simulations. The latter has been found instrumental in teaching physics, since it assists with the representation of many physical concepts that normally students have considerable difficulty visualising and understanding. Learning challenges can become even greater when students do not have real world experiences or mental images of the investigated concepts. Such concepts include flux, electric potentials, electric fields, imaginary Gaussian surfaces, etc. (Sadaghiani, 2011), which constitute the topic of interest for two thirds of the investigated unit. Further support was provided via direct references to the OpenStax University Physics Volume 2 open access electronic textbook (Ling et al., 2016), that students are encouraged to access throughout the whole course of the unit.

Special emphasis was likewise placed during the unit designing stage to develop relevant assessment tasks with direct links to the unit's learning objectives and developed blended activities. Online based in-class quizzes randomly generated from the same question banks were undertaken for each investigated topic in the first hour of every first session in weeks 2, 3, and 4. Students are also instructed to record their problem solving process in writing, so that cross-referencing against their online responses can be used for the provision of feedback and partial marks. The term hybrid is thus used to describe the dual submission protocol (online & paper based) of these tests. The remaining marks were allocated for students' efforts in the corresponding inquiry based and laboratory based activities, including their video presentation.

Methodology and Empirical Study

This investigation focuses on identifying if a correlation exists between student participation in any of the four utilised blended activities (i.e., videos, electronic textbook, online simulations/applets, and practice quizzes) and their test performance in three linked in-class hybrid tests. It was hypothesised that students who spend considerable amount of time using the developed blended activities would exhibit more effective learning gains despite the apparent time constraints of this unit running within a Block Teaching Model. Learning gain was assessed by comparing student performance on the BEMA multiple-choice instrument that tests understanding of subjects covered in a typical introductory electricity and magnetism course (Ding, Chabay, Sherwood, & Beichner, 2006).

Our data set consisted of a total of 90 1st-year (predominantly engineering and also a few education) students. Students that may have enrolled and never attended any classes or dropped the unit before the end of the block have not been included in this study. Student participation data were manually extracted from the automatically generated learning analytics (LA) that are available on the VUC platform throughout the duration of each taught block. In all, this unit was offered over a period of four different blocks and collection and analysis of data was performed after the end of each of the four blocks.

Table 2
Summary of blended activity LA and corresponding empirical study

Blended Activity	**LMS Analytics**	**Empirical Study Variables**
Pre-class HTML5 rich interactive videos	Video Watching time & number of video visits	Students that spent 60 minutes or more during a topic vs those that spent less than 60 minutes.
References to Open Access Electronic Textbook	Number of visits	Students having accessed 50-100% of the notes vs students having accessed less than 50%.
Links to Online Simulations & Applets	Number of visits	Students having accessed 50-100% of the applets vs students having accessed less than 50%.
Post-class Practice Quizzes (PQ)	Number of PQ attempts & time spent on PQ	Students having practiced on average one time or more per PQ quiz versus students that practiced less than one.

Table 2 presents a summary of the extracted LA as a function of blended activity and corresponding empirical study. As noted earlier, each video lasts on average around 10 minutes, which can be considerably extended when students reflect before providing answers to questions embedded within the video. As such, a large diversity in total watching time was observed for different students, which was further intensified when comparing data between different sessions. It was therefore decided to analyse the effect of the total video watching time over every three sessions, which corresponds to the number of sessions used for each of the three explored physics topics. The effect of videos as a function of student performance in the corresponding end-of-topic hybrid in-class test was then analysed by comparing students that on average have spent more than 60 minutes of watched time versus students that spent less than 60 minutes.

When studying the effect of the open access electronic textbook or that of relevant online simulations and applets, data was only available in the form of if these resources were accessed by the students or not. The average number of visits over the total number of sessions was then compared as a function to the average total mark for the three end-of-topic tests. A comparison between students having accessed more than 50% of either blended resource versus students that did not was then undertaken.

The impact of practice quizzes (PQ) on student performance was investigated by comparing the average number of PQ attempts per session as a function of the average total mark for the three end-of-topic tests. Likewise, assessment of student learning gain with the aid of the BEMA instrument was achieved by looking into the average number of PQ attempts per session over the first six sessions only. The BEMA was used as both a pre-test (first session of the block) and as a post-test (eleventh session of the block). The normalised learning gain was then computed, which is the ratio of the actual to the maximum possible gain (Sadaghiani, 2011).

Data Analysis and Results

As noted earlier, four sets of LA data were collected and analysed in conjunction with students' scores on corresponding end-of-topic hybrid quizzes and student performances on the BEMA test. Figure 1 represents the student score distribution on the three end-of-topic hybrid in-class tests as a function of watched video time. It can be observed in all three cases that a significantly better grade was achieved when students spent more time interacting with the corresponding pre-class videos. On average, close to 75% of students achieve a mark of around 60% and over when they have spent twice as long time as the duration of each video per session. Only about 50% of the students achieve a similar result from the other group. Likewise higher medians are showcased in all tests for the first group of students (Electricity test: 0.71 vs 0.63, Magnetism Test: 0.84 vs 0.61, and Thermo Test: 0.71 vs 0.62) with all differences appearing statistically significant when undertaking a two-sample (assuming unequal variances) significance test (p-values of 0.0014, 0.0001, and 0.0003 respectively for the three sets of data).

Similar data analysis was performed when investigating the link between accessing the recommended open access electronic textbook or relevant online simulations/applets and distribution of the average student score in the three tests (Figure 2). Comparing the computed median values, it becomes clear that students that have accessed more than 50% of either type of blended resource performed better in the corresponding quizzes (Electronic Textbook: 0.73 vs 0.61 and Online Simulations: 0.73 vs 0.59). A two-sample (assuming unequal variances) inferential statistics test shows that the observed differences are significant (*p*-values of 0.003 and 0.038 for the two sets of data).

Analysis of data regarding the effect of practice quizzes was performed by identifying the impact on students' test scores as well as improvements in student conceptual understanding using the BEMA instrument. It was found that students undertaking a PQ at a rate of over one per session greatly outperformed those that did not (Figure 3 – Solid Filled Box Plots). Over 75% of students from the first group achieved an average test score of 60% and over, while only about 30% of students from the second group achieved similar marks, with these differences once again appearing statistically significant (*p*-value of 3.24×10^{-5}).

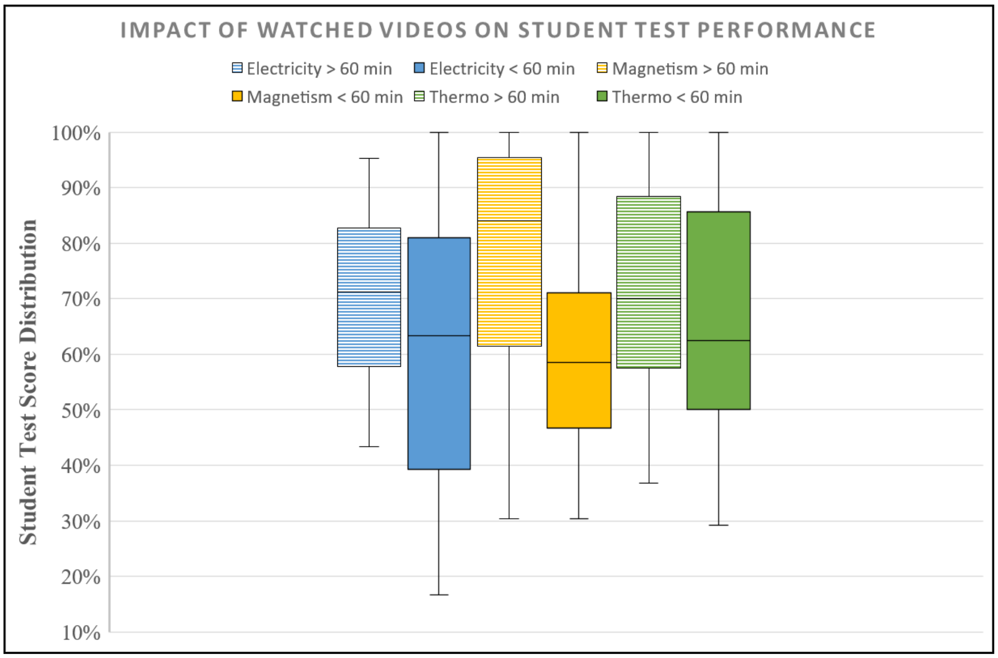

Figure 1. Impact of time watching pre-class videos on test score.

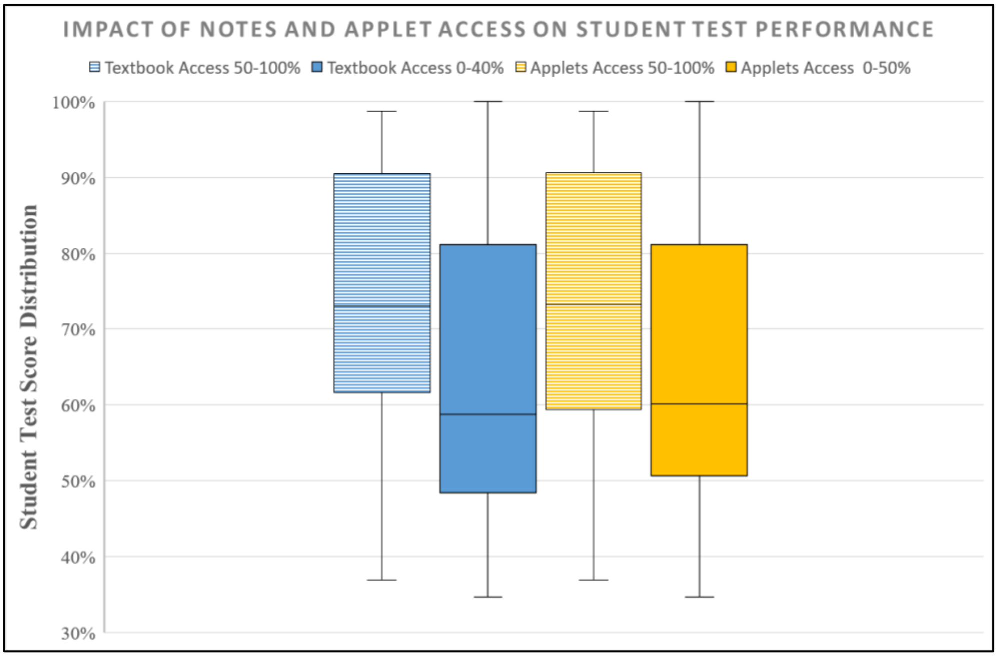

Figure 2. Impact of accessing the electronic textbook (leftmost blue spans) and applets (rightmost yellow spans) on test scores.

Although no significant difference in pre-course BEMA results had been observed between the two groups, students undertaking more practice quizzes outperformed those that did not in the post-course, resulting in a roughly 5% higher normalised learning gain (29.91% vs 25.03%).

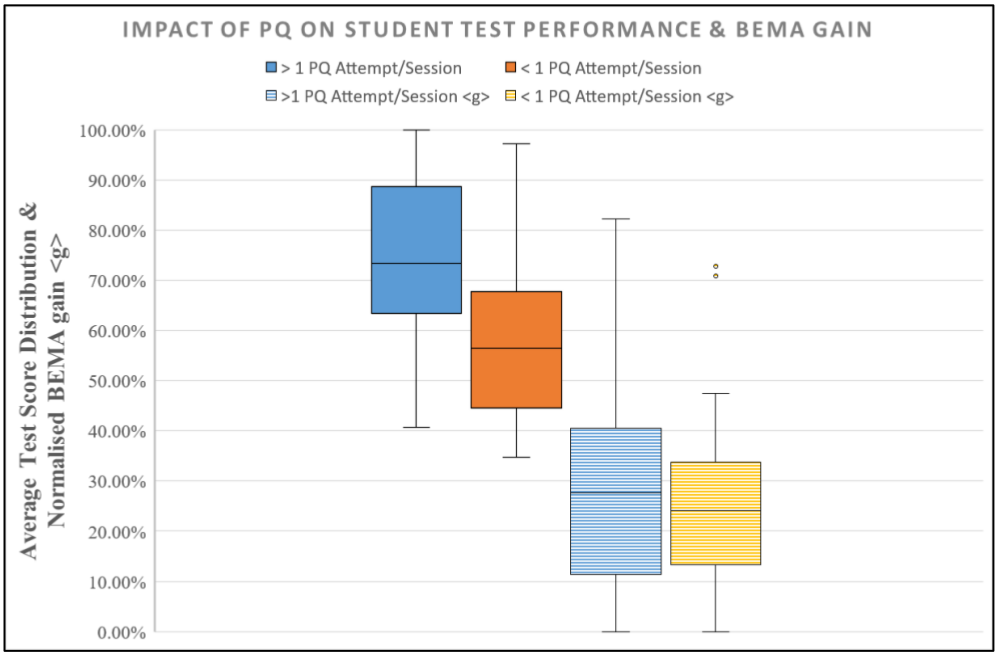

Figure 3. Impact of practice quizzes on test scores (leftmost solid box-charts) and on normalised gain (rightmost pattern filled box-charts).

Conclusion

This study investigated the effects of using a range of blended learning activities on students' performance in an introductory university physics unit delivered under the recently adopted Block Teaching Model. The findings suggest that uptake of the available blended resources can significantly increase the possibility of students achieving a higher overall mark as well as demonstrating a higher conceptual understanding at the end of the unit, despite the apparent time constraints of this unit running within an intensive teaching format. Based on the outcomes of the BEMA instrument, it was found that students' overall conceptual understanding ($44\% \pm 17\%$) was comparable to what has been shown in previous studies assessing students under the traditional mode of teaching ($44\% \pm 13\%$) (Maloney, O'Kuma, Hieggelke, & Van Heuvelen, 2001).

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IMPROVING STUDENT ENGAGEMENT AND SELF-REGULATED LEARNING THROUGH TECHNOLOGY-ENHANCED STUDENT PARTNERSHIPS

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Abstract

Teaching and learning in higher education for the Science, Technology, Engineering and Mathematics disciplines are renowned for their challenges. This paper explores how embedding a personal learning platform (PebblePad) through a Students as Partners (SaP) initiative has resulted in a higher degree of student engagement in a second-year biochemistry course and unexpected benefits for students based on reflections about their experience. Adopting a digital platform enabled surprisingly honest, uninhibited and extensive student reflections. In addition, while the coupling of the SaP initiative with educational technology has exceeded expectations, early findings suggest that the process is also contributing positively to students' self-regulated learning.

Introduction

One of the major problems facing higher education is the decline in student engagement and participation in classes, particularly the low attendance of lectures (Armbruster, Patel, Johnson & Weiss, 2009). Even more concerning is the lack of participation in small problem-based classes and tutorials which are crucial for learning in STEM disciplines. Informal conversations with students highlighted their fear of failure or ridicule from fellow students as the reason for not being engaged. They also suggested that they were more likely to engage activities involving anonymity, such as clickers which are also used in our classes. One strategy that is currently changing this trend is a Students as Partners (SaP) approach, which has been shown to increase engagement, and subsequently student learning (Cook-Sather, Bovill, & Felten, 2014; Healey, Flint, & Harrington, 2014). This strategy involves building partnerships in teaching and learning between students and academics, allowing students to become empowered and part of a community, negotiating the terms of the partnership and taking ownership in the co-creation of curriculum and assessment (Bovill, Cook-Sather, & Felten, 2011; Cook-Sather et al., 2014; Healey et al., 2014; Matthews, 2017). Conceptual models for SaP have been developed as a means of exploring ways to develop partnerships between students and academics (Healey et al., 2014; Healey, Flint, & Harrington, 2016). More recently, a literature review of SaP in higher education (Mercer-Mapstone et al., 2017) uncovered a vast array of positive outcomes for student-teacher partnerships through increased engagement, motivation, and ownership of learning as well as gaining trust and enhancing relationships. These are just a couple of the positive aspects of SaP which were key to our adoption of this strategy. To address the dwindling engagement in a second-year biochemistry course (~120 students), a SaP approach was adopted to provide students with an opportunity to choose topics for part of the course through a democratic vote and design multiple choice questions negotiating the terms of student-generated questions for assessment. A personal learning platform (PebblePad) enabled students to engage in the SaP approach, providing an environment for completing activities, negotiating the terms of the partnership and a safe space for reflection and evaluation. It has been suggested by Winne and Stockley (1998) that using computers as a medium for learning can not only provide detailed feedback about a person's learning efforts but also has the potential for raising self-observation to new levels.

Literature Review

Technology for Learning

It has been taken for granted that introducing technology will result in 'enhanced learning' (Kirkwood & Price, 2014) although it has been recognised that technology-enhanced learning environments can be effective platforms for student learning and reflection (Kori, Pedaste, Leijen & Matoes, 2014). Conole and Dyke (2004) have identified reflection as an ICT affordance but emphasise that there is nothing inherent about ICT that nurtures reflection. Instead, the key is **how** ICT is used as it "has the potential to enable reflection and criticality to be enhanced" (Conole & Dyke, 2004, p. 118). Salomon describes Gibson's concept of affordances whereby 'affordance' refers to "the perceived and actual properties of a thing, primarily those functional properties that determine just how the thing could possibly be used" (1993, p. 51). In the context of this SaP intervention, the affordance of PebblePad and Atlas (the learning analytics component of the tool), provided opportunities to monitor student progress with the assessment task and their reflective responses to the partnership experience. Another advantage of implementing a SaP approach through a personal learning platform was the opportunity to collect data (with ethics approval). From a research perspective, Winne and Stockley explain the value of technological tools "as replacements for the researcher's intrusive methods for gathering data" whereby they can "meticulously and reliably observe, tirelessly and unerringly sift, and usefully assemble and coordinate massive volumes of data that characterise a student's 1) achievements and 2) the studying tactics the student uses to forge those accomplishments" (1998, p. 132). Therefore, a technology-enhanced approach afforded opportunities to implement and evaluate the Students-as-Partners initiative.

Students-as-Partners for Learning

The metaphor of 'students as partners' "imagines and makes way for respectful, mutually beneficial learning partnerships where students and staff work together on all aspects of educational endeavours" (Matthews, 2017, p. 1). Such relational staff-student partnerships provide a "collaborative, reciprocal process through which all participants have the opportunity to contribute equally, although not necessarily in the same ways, to curricular or pedagogical conceptualization, decision-making, implementation, investigation, or analysis" (Cook-Sather, Bovill & Felten, 2014, p. 6-7). As Bovill, Cook-Sather, and Felten assert, "student voice is premised on the notions that students have a unique perspective on teaching and learning and that they should be invited to share their insights, which warrant not only the attention but also the response of educators" (2011, p. 133). Bovill, Cook-Sather and Felten explain that such assertions are supported by Hattie's (2008) meta-analysis of student achievement, whereby he "argues that student learning is deepest when students become their own teachers and when their teachers learn from them through feedback and other means" (2011, p. 134).

However, it is important to consider that the form of student and staff participation needs to be fit for purpose in any students-as-partners initiative. Bovill (2013) clarifies that when it comes to staff–student partnerships, they are complex and contextual. Academic staff and students bring different levels of expertise to the process – an aspect that students recognised in their reflections, which is identified in the results and discussion section. Therefore, co-creation in either curriculum design and assessment "is not about giving students complete control, nor is it about staff maintaining complete control over curriculum design decisions" (Bovill, 2013, p. 464).

Partnerships are central to this case study. Partnerships involves "negotiation through which we listen to students but also articulate our own expertise, perspectives and commitments" (Cook-Sather, Bovill, & Felten, 2014, p. 8). This case study was guided by Matthews' five propositions for good practice (2017), which underpin genuine Students as Partners approaches. These propositions are presented below with a brief reference to how this case study aligned with Matthews' recommendations.

1. *Foster inclusive partnerships* - Diversity and inclusion are paramount to good practices in SaP approaches (Matthews, 2017). In particular, SaP in higher education "needs to create spaces for participation and partnerships where members from differing social classes, countries, backgrounds" and other diverse demographic groups can collaborate in teaching and learning (Matthews, 2017, p. 2). Extensive research across the STEM disciplines has demonstrated that active learning strategies form an integral part of teaching and learning to student success in the sciences, particularly for underrepresented minority groups such as 'first in family' (Freeman et al., 2014). For this case study, more than 50% of the 128 students were 'first in family' with 25% of students in this course from Non-English-speaking backgrounds at home.

2. *Nurture power-sharing relationships through dialogue and reflection* - Technology-enabled personal learning environments (PLE) and learning technologies can provide a ‘safe’ learning environment for students to reflect on a range of learning opportunities. In the context of this case study, students used a PLE called PebblePad in which a reflective assessment ‘workbook’ was designed that students shared only with the lecturer. This enabled students, as co-creators of curriculum, to choose two topics in a democratic process and justify the reasons for their preferences. The digital workbook also enabled students to reflect on and answer questions honestly about the whole ‘students-as-partners’ process.

3. *Accept partnerships as a process with uncertain outcomes* - As this initiative was a first foray into SaP, it was uncertain about the extent to which students would engage with the process and how successful it would be in achieving the desired outcomes. Therefore, two key aspects of the intervention’s design were considered. Firstly, for students, any assessment would be low stakes but to encourage all students to engage with the process, marks (<10% of total grade) were associated with it. Secondly, students would receive full marks if they completed all the elements of the process and assessment. This ‘competency approach with low stakes’ was intentional to encourage students to be honest in their reflective comments for evaluation of the approach so they knew that they would not be penalised if their responses reflected that they did not like the SaP process.

4. *Engage in ethical partnerships* - Matthews identifies three components of ethical SaP practices:

    > the ethics of reciprocal, mutually beneficial practice necessitates a process of power-sharing between all involved; mutualistic partnerships benefit all involved who are working together for good; [and] ethical practices in learning and teaching partnerships mean serving more than the individuals involved as SaP is part of a broader movement for social good grounded in democratic principles. (2017, p. 5)

    This case study aimed to be inclusive of all the students involved and created a safe and ethical learning environment.

5. *Enact partnership for transformation* - Matthews explains the transformative potential of partnerships to “create a culture of partnerships grounded in the values of respect, reciprocity, and shared responsibility for learning and teaching between students and staff as equal members of the university community” (2017, p. 6). This case study is shared through a range of professional learning opportunities and the SaP approach is part of the university’s learning and teaching strategic plan.

Self-regulation for Learning

There are a variety of conative factors, such as self-regulation, which play a central role in influencing students' academic performance in higher education (Boekaerts, Pintrich, & Zeidner, 2000). Zimmerman defines self-regulated learning as "the self-directive process through which learners transform their mental abilities into academic skills" (1998, p. 2). Self-regulated learners are characterised as active learners who seek out further learning opportunities and resources when they encounter difficulty (Johnson, 2019; Zimmerman, 1990). Johnson succinctly explains that self-regulated learning "is the ability of learners to mindfully proceed through learning tasks, to continually check their understanding as they advance, and to reflect on the learning task after completing it" (2019, p. 133). Self-regulation involves "cognitive, affective, motivational, and behavioural components that provide the individual with the capacity to adjust his or her actions and goals to achieve desired results in light of changing environmental conditions" (Zeidner, Boekaerts, & Pintrich, 2000, p. 751). Essentially, conceptualisations of self-regulation embody the fundamental elements of goal setting, steering processes and strategies, feedback, and self-evaluation (Zeidner et al., 2000). An important distinction between self-regulation and regulation is that the person/student is driving the behaviour on setting a goal or defining a relevant procedure (Zeidner et al., 2000). Zimmerman (2000) proposes a social cognitive model which considers the processes in how university students self-regulate their learning in order to improve their performance. Self-regulation is achieved in cycles consisting of three phases: forethought; performance; and then, self-reflection (Zimmerman, 2000).

Proficient learners have the capacity to self-regulate (Butler, 1998). The key to how successful learners approach academic tasks is skilful strategy (Schunk & Ertmer, 2000). Such learners strategically analyse task requirements, define the criteria for successful completion, and establish realistic goals (Butler, 1998). An essential phase of self-regulation involves self-reflection (Zimmerman, 2000). In the light of the model of self-regulated learning, Butler explains that self-reflective practice requires students to "analyse task requirements carefully, evaluate and select strategic approaches, monitor the qualities of their performance and the success of their strategies they implement, and then modify goals or learning strategies adaptively based on the progress they perceive" (1998, p. 177).

Methods

Students-as-Partners Strategy

Our SaP approach was designed to encompass those propositions outlined by Matthews (2017) which demonstrate a genuine partnership with students in the learning process. Empowering students by providing opportunities for them to be involved and contribute to the course design and the assessment would hopefully increase participation and engagement in the course. As our first venture into partnerships with students in learning and teaching, we decided to start small, providing an avenue for student to reflect on their experiences and evaluate the impact of the partnership. Technology supported the SaP approach by using scaffolding to complete the partnership activities and negotiations as well as capturing students' reflections. There were three aspects to the partnership: to allow students to choose from a range of topics for part of the course through a democratic voting process; to provide an opportunity for students to design assessment and negotiate the level of student generated questions in the final examination; and finally, to provide a forum for students to reflect on their involvement in the partnership.

Topic Selection

Many science courses are jammed full of content and this second-year biochemistry course is no exception, although a proportion of the core content in this course is required knowledge for transition through to future second and third year courses. The introduction of this SaP approach was designed to maintain the required core concepts for progression and allow students to choose topics they wanted to learn for the remainder of the course. A reduction in the semester length by the university as it transitioned to trimesters provided an opportunity to re-frame the content. Students were able to vote for the two topics they wanted to learn from a selection of six topics. As the topics were inter-related, we felt it wouldn't matter whether they were learning protein engineering and proteomics, or protein therapeutics and protein crystallography. If students could choose what they wanted to learn, then this might increase their engagement in the course.

Student-generated Assessment

In addition to choosing topics for the course, students were provided with an opportunity to contribute to the assessment, designing multiple choice questions and negotiating how many student generated questions appeared on the final exam. Scaffolding resources and instruction on developing multiple choice questions were provided to assist students in creating exam questions. Students were provided with feedback in the form of written comments and a rubric, and approximately 100 questions were created that were relevant to the topics covered in the course. A negotiation was conducted to decide on the percentage of student generated questions that would appear on the final exam. Students were able to vote a minimum of 10% up to a maximum of 50% for the multiple choice section on the exam. The student generated questions were used to create an online practice quiz which could be used as a study resource. The practice quiz generated 10 random questions and students could take the quiz as many times as they wished.

Partnership Reflection and Evaluation

Understanding the student's perspective of the partnership activities and negotiations was vitally important for reflection and improvement of the SaP approach, and to gain an insight into the ways students were engaging in partnership negotiations and contributions. Students were required to provide a reflection on both choosing topics and designing multiple choice questions. In addition, an overall evaluation was conducted as one of the partnership activities and students were questioned on whether the partnership increased their engagement; had an impact on their learning; the importance of contributing to the assessment and the course design; and if they were able to contribute further, would it be to the curriculum, the assessment, or both.

Results and Discussion

Student reflections in the personal learning platform provided the real insight into student motivation and engagement. The level of student engagement in the SaP in the course surprised the authors, particularly student reflections, which were a minimum of 20 words, and students provided paragraphs, elaborating in detail and with honesty. Of the students who participated in the SaP task, 86.4% rated the partnership experience for the curricula and assessment design as useful (52%) or very useful (34.4%), and 80.5% indicated that they were engaged (32%) or more engaged (48.5%) through involvement in the course design and assessment. Student reflections provided direct insight into students' perceptions of the partnership, and endless information about student learning, metacognition, motivation and knowledge construction.

Student Voice – On Topic Choice

The majority of the reflections on the choice of topic related to students' future courses or degree programs or topics that they thought would be interesting, for example, "*I believe these topics could be of use in my future as a researcher*", and "*I chose Protein Therapeutics because I find it fascinating how proteins can be used to treat medical conditions*". Another student stated that, "*I liked that I got to study a topic I chose for once*". With respect to designing multiple choice questions for assessment, students overwhelmingly commented on the difficulty of this task, such as "*It was a lot more difficult than I anticipated*". While many suggested that this supported their learning, for example, "*it forced me to have an understanding of the content to create questions in which I could ultimately test myself on, further improving my knowledge*". However, some students would prefer greater autonomy, e.g., "*I felt like the student topics weren't long enough or in depth enough. I'm not sure if that's Griffith Uni policy issue or something but if the choice we get isn't equally weighted against the others it kind of defeats the purpose in a way*". A final student comment is a testament to our successful foray into SaP, but also demonstrates how student choice "contributes to learners taking more responsibility for their own learning" (Bovill et al. (2011, p. 135): "*Choosing a topic meant an increase in engagement and interest, and choosing questions for assessment meant that I had to filter through what I know, didn't know and what gaps I had in my knowledge*".

The SaP process continued for the 2019 offering of Protein Science. While the student cohort chose a different topic to the 2018 cohort, early student comments appear to reflect similar responses to the 2018 cohort. For instance, choosing a topic has reflected elements of personal and/or professional relevance for students as well as intrinsic motivation. For example:

> *Proteomics – I did not understand what proteomics was, so I conducted a google search that led to some incredibly interesting articles regarding the increasing push of proteomics research, aiming to fill the gaps and shortfalls of gene analysis, genomics. I therefore feel enhancing my understanding of proteomics would have a practical use in future stages of my study."* and *"Protein therapeutics – I am currently a nurse, and have a fundamental interest in medical interventions, especially the science behind them. Personally I'd love to learn more about how many of the treatments I may already be using function at a molecular level.*

Student Voice – On Assessment Design

Students designed multiple choice questions (MCQ) and voted on how many should be on the exam. Students were asked to: *Comment on your experience in developing a multiple-choice question for an exam*. Many students commented that the task was valuable, enjoyable or interesting. In particular, 36.4% of students stated that the task was challenging and more difficult than they anticipated. Approximately one third (32.3%) mentioned that designing an MCQ required knowledge and understanding of the topic and this improved their learning and understanding. Another six percent of students stated that designing an assessment assisted with revision of the topic. For example, *"The ability to write your own multiple choice question was a great learning experience as it was a great way to reorganise notes and study for the different modules in a new way which led to learning more conceptually instead of rote learning"*. Many students not only found the task of designing exam questions difficult but also they reflected on their understanding of the topic and if improvements were required, such as *"Writing a multiple choice question was harder than I thought it would be, however, it did help highlight the topics I understand well, and those that may need improvement"*. Clearly students are not only reflecting on their level of understanding and adjusting their learning as a result, which appears to follow the self-regulated learning process outlined by Zimmerman (2000).

Student Voice – Insights into Self-regulated Learning

Early findings suggest that self-regulated learning is central to students completing the assessment tasks**.** Several student comments on designing multiple choice exam questions appeared to align with Zimmerman's cyclical phases of self-regulated learning (2000). For example:

> *Generating a multiple choice question that can be both challenging and requires thinking time for the person trying to answer the*

> *questions can be both daunting and time-consuming. During this exercise I had to go over some notes from lectures and textbooks. From this, I was able to reinforce the method of gel electrophoresis. I tried my best to use it in an applicable situation. I found the exercise worthwhile and a good study revision.* (see Figure 1).

> *I found this experience to be more difficult [than] I had anticipated and often found myself formulating questions that were either far too difficult or obscure and others that had been too blatantly obvious. Despite this I did enjoy reflecting on exam questions I have read in the past and trying to emulate their tone and level of difficulty in order to help me create this multiple choice question. Overall I am grateful for the opportunity to design a question even if it may be a poorly structured one and I now appreciate the difficulty behind having to create an exam question.*

Interestingly, Steffens (2006) asserts that self-regulated learning can be considered too narrowly or does not explicitly take into account the learner's personal goals. This student's comment captures not only the goals of performing the task but also their professional aspirations:

> *It puts you in an examiner's shoes. You must consider what questions will best test not only the memory of a topic, but the understanding of a topic as well. Prompts you to analyse concepts in detail and apply them to real world problems or questions you might come across in the field [of] protein science. Also places you in the perspective of a scientist in terms of solving problems, asking certain questions or performing certain tasks by referring to the knowledge of these topics in the field of protein science.*

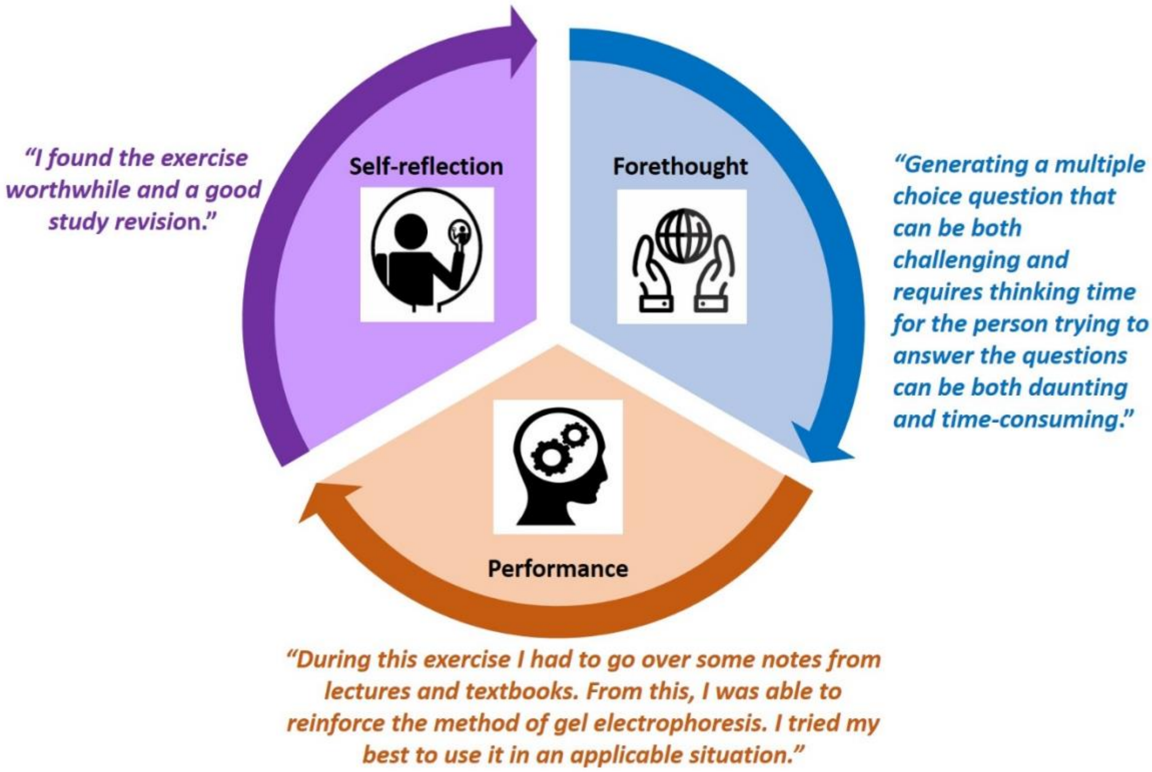

Figure 1. Student reflection on assessment design: our interpretation of self-regulated learning.

Student Voice – On the Students-as-Partners Experience

Providing a forum for student reflection and evaluation of their partnership experiences was a very valuable aspect of the SaP initiative. In particular, the students' reflective responses to the topic-choice question provided insights not only into the extent to which they valued the democratic process but also their experiences of the process. For example: *"I liked the idea of putting the topic choices to a democratic decision, for the cohort to choose what would be the best for them to learn, and as to what would prove the most interesting for the entirety".* Several students emphasised the importance of having a say was important to them as the learners, for instance *"I seriously loved the idea of actual students contributing to the assessment and I would love, love, love to see more of this in future courses. It's simple really because at the end of the day it is US who are learning the content and being able to have a say on what parts of that content we get to be assessed on is totally awesome".* There were no specific questions that focused on the adoption of a PLE; however, there were two specific comments about the technology in students' overall reflections: "*I don't like PebblePad though … no reason why … If you guys could find another platform to use that would be cool*" and "*While PebblePad was annoying, I think that it was a good way to do this assignment*".

Conclusions

The overall impact of introducing a Students-as-Partners (SaP) approach to improve student engagement in the Protein Science course has been extremely successful. The surprising collateral benefits of this SaP approach were the unexpected ways that the process supported student learning. While students indicated that they were more engaged in the course as they could select topics of their choice and contribute to the assessment, based on our observations, this did not appear to lead to greater participation in classes or increased attendance in lectures. However, the uninhibited reflections provided direct insight into students' positive perceptions of the partnership, and valuable information about student learning, metacognition, motivation and knowledge construction. The technology-enhanced approach also enabled an unforeseen richness in students' reflections. This surprising level of students' reflections provided was enabled by the implementation of a personal learning platform (PebblePad) where each student could privately and honestly reflect on their learning experience.

Acknowledgements

We would like to acknowledge David Green and Christopher Allan, Learning and Teaching Consultants (Design), Griffith Sciences, Griffith University for their support in the design of the PebblePad workbook used for our SaP approach.

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TEACHING TO SOLVE GLOBAL WARMING WITH DATA SCIENCE

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Abstract

We report on the design and execution of a Data Science assignment in which students work on Global Warming issues and predict the outcome of solutions. The paper outlines how to solve Global Warming through the design of an assignment and gives elements of answers to research questions regarding research in the classroom, the benefits to students and how to influence policy makers.

Introduction

In this paper we report on conducting Data Science research in the classroom with two groups of Bachelor students. We are interested in knowing:

1. RQ1: Whether it is possible to do Data Science research in the classroom and how;
2. RQ2: how it benefits the students; and
3. RQ3: if the discoveries made are valuable.

To answer to RQ1, we describe our methodology in setting up the class, the various activities undertaken with the students and the artefacts produced. We set ourselves to research and solve Global Warming. RQ2 is answered by carrying out a survey with the students, focusing on how they benefited from the class, what could be improved and what they learned. To evaluate RQ3 we share the results of the students' research and their findings about global average temperature, gas emissions and potential solutions. We discuss how to improve this process, how to involve the students better, and future directions.

Solving Global Warming

Global warming is a major environmental issue of our time. The gas emissions due to industrial changes and the increase of population lead to a rise of the global average temperature and sea level as the ice melts. This results in dramatic disasters, floods, earthquakes, storms and species extinctions. Recently it has been shown the largest king penguins' colony has collapsed (Weimerskirch, Le Bouard, Ryan, & Bost, 2018), its population falling from 2 million individuals to 90,000. Another alarming fact is the change in the ocean microbiotic life; Morán et al. (2015) have shown the bacteria are smaller and there are more of them as a result of global warming. What is the effect of this on the rest of ocean life? The reader will certainly find many more examples of such disasters. So, what do we do about this? Even though the situation is dramatic, there are solutions, e.g., limiting the gas emissions has been shown to enable stopping the temperature rise (Smith et al., 2019) while keeping it under the 1.5 degrees boundary. Planting trees would get the temperature back to a normal level: there are three trillion trees on the planet according to Crowther et al. (2015) and another 1.2 trillion would be necessary to absorb the excess of CO_2 in the atmosphere based on Goymer (2018). Identifying major industries and activities which contribute to gas emissions and convincing people to find alternatives is essential, as are reforestation efforts and planting trees in arid areas.

Data Science

Data Science is a recent research field of Computer Science evolving from Statistics, Data Mining, Data Visualisation and Machine Learning. Since much larger amounts of information are available, the diversity of the analyses which can be performed is vast. Every industrial sector needs data scientists to work on their data flow; therefore, the profession is growing quickly. The typical Data Science process consists of collecting data, cleaning and pre-processing the data, applying data mining or machine learning algorithms, performing analysis and producing visualisations to communicate the knowledge extracted. In previous occurrences of a Data Science class, students worked on the musicbrainz database for their assignment (Mesnage, 2017) and in a social software class (Mesnage & Jazayeri, 2008). How can Data Science help in solving Global Warming?

Design of a Data Science Assignment

The assignment proposed is composed of 11 tasks ranging from researching the topic of Climate Change, to finding relevant datasets, plotting data, making predictions and predicting the outcomes of solutions. The goal is to convince policy makers on changing behaviours and taking action. Figure 1 provides the text of this assignment.

> Global warming is a problem clearly identified, the result of human industrialisation which recently led to disastrous gas emissions in the atmosphere. The climate is getting warmer every year due to the lack of ozone in the stratosphere and the presence of greenhouse gas. In this assignment you will work on climate change data to gain insights on global warming and motivate solutions.
>
> Task 1. Research the topic of global warming and outline ideas on how Data Science can help. List potential solutions and how to influence policy makers.
>
> Task 2. Based on your knowledge of Next Generation Databases discuss the advantages of the different NoSQL database categories to store climate change data.
>
> Task 3. Find a relevant dataset to climate change (for instance global sea level or average global temperature, effect of planting trees/deforestation, gas emissions of cars, planes, ships, veganism...) on https://toolbox.google.com/datasetsearch and write a Python script to load the data and import it in a MongoDB database.

Task 4. Write 3 JavaScript queries to access your data from your MongoDB database.

Task 5. Based on your knowledge of Data Science and your readings, discuss the different data mining methods that can be applied to climate change data and what insights they can give you.

Task 6. Use https://toolbox.google.com/datasetsearch to find a relevant dataset, open it with Orange and plot the data with a Scatterplot.

Task 7. Recall how the Kmeans algorithm functions and the purpose of clustering. Apply the Kmeans algorithm to cluster data. You might need to process the data or link it with another dataset. For instance, you could cluster UK cities based on their gas emissions levels.

Task 8. Apply a classification tree and a classification tree viewer to the output of Kmeans. Produce the screenshot of the tree and interpret the results.

Task 9. Explain the APRIORI algorithm to compute frequent itemsets. What is the complexity of the problem of finding frequent itemsets and what is the technique used to improve its efficiency? If applicable, find association rules on your data or find another relevant dataset; for instance, you could find patterns of pollution levels and economic activities in regions.

Task 10. Use linear regression, polynomial regression and neural networks to predict the global average temperature in the coming 30 years; compare and discuss the results.

Task 11. Research prediction models of the global average temperature using gas emissions and predict the 5 year outcomes of solutions to global warming. Use the tool colab (https://colab.research.google.com) and your knowledge of Python for data visualisation to conduct this task.

Figure 1. Assignment 11 tasks.

The assignment was completed by 43 students to various levels of success. One student had an interesting take on task 11, which we will look at in the next section.

Elements of Answers

In this section we answer our research questions, by looking at the student work for some of the assignment tasks, the student feedback, success rate and discussions with policy makers.

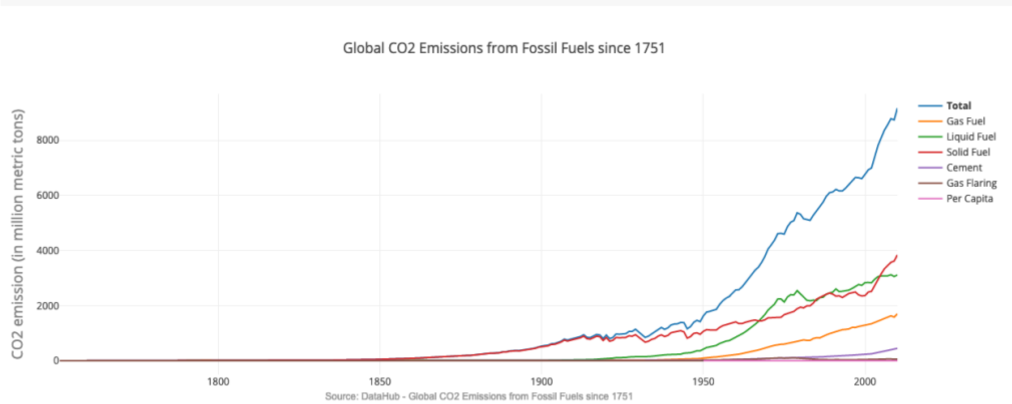

Figure 2. Line chart of global emissions.

Figure 2 shows the work of a student in building a visualisation showing the datasets of provenance of CO_2 emissions.

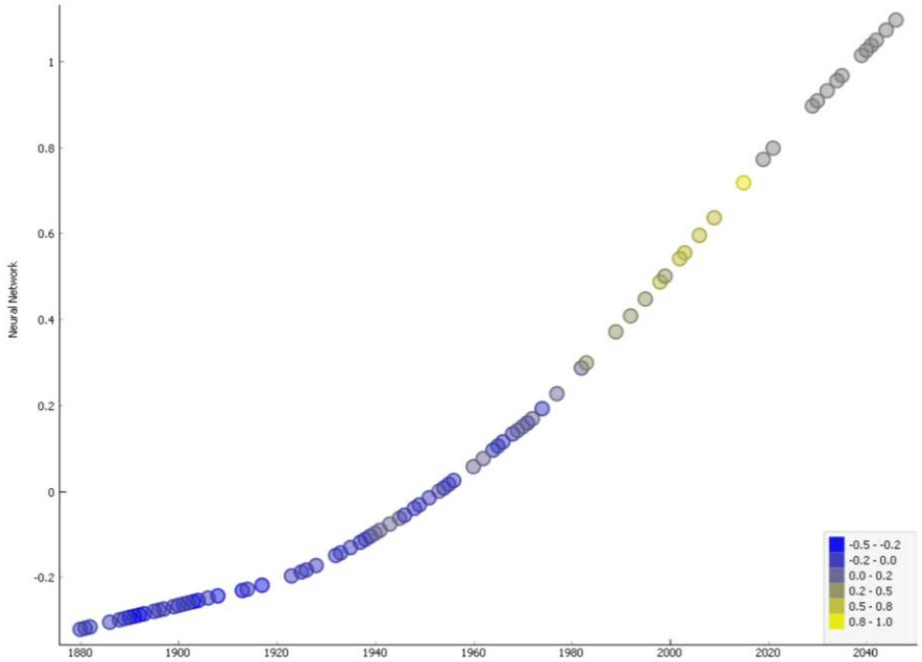

Figure 3. 30 year prediction of the global average temperature.

The neural network model used in Figure 3 to answer question 10 suggests a temperature change of 1.524 degrees celsius until 2046, which is consistent with climatologists' predictions and alarming.

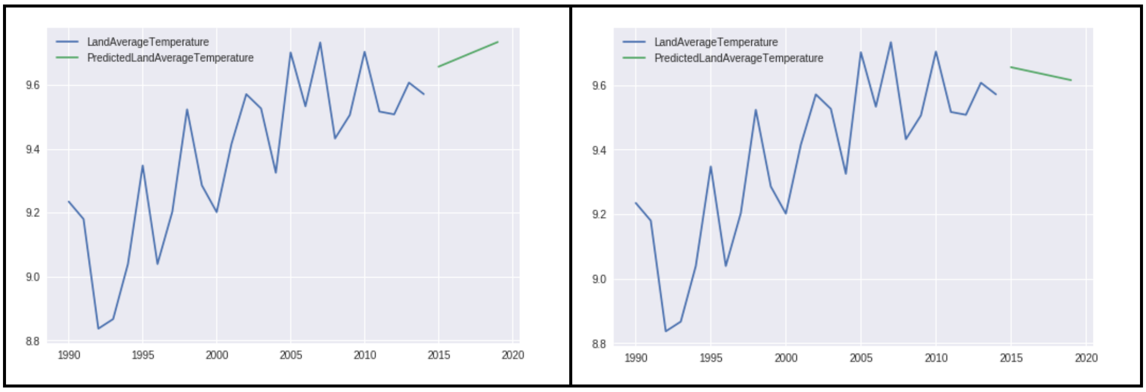

Figure 4. Predicted global average land temperature without (left graph) and with (right graph) increasing the number of planted trees.

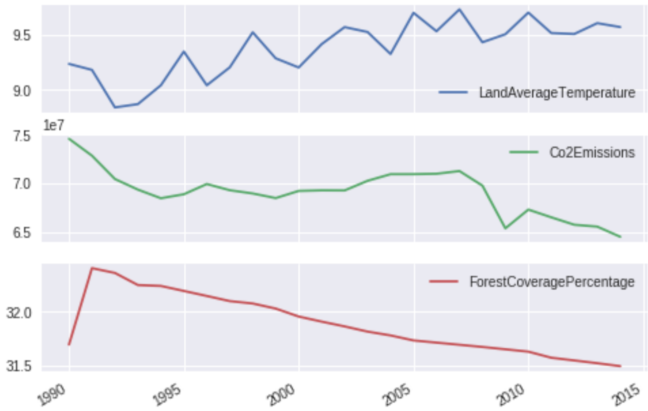

Figure 5. Datasets used for the prediction of the solution.

Figures 4 and 5 depict the work of a student in predicting the outcome of increasing the forest coverage of Earth, answering task 11. They show a potential regression of the global average land temperature in the case of an increase of the number of trees, which is an optimistic look on the problem and corroborates the work of Goymer (2018). By combining the land average temperature, the CO_2 emissions and the forest coverage, he trained a neural network model on the dataset shown in Figure 5 and used it to make the predictions in Figure 4, either with a continuing decrease of forest coverage or an increase of forest coverage.

This clearly answers our RQ1, as students have shown it is possible to do data science research in the classroom with the fantastic work they produced. As Little, Brookes, & Palmer (2008) discuss, research informs teaching, as well as teaching informs research.

Student Feedback

Ninety-seven and a half percent (97.5%) of students passed the class, which shows a great motivation to work on the assignment.

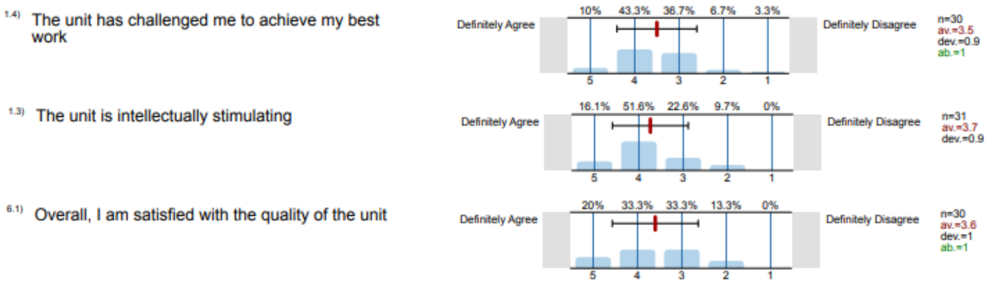

Figure 6. Student survey results.

Figure 6 shows some answers to the unit survey on student satisfaction, which are the questions most relevant to RQ2. Student found the assessment challenged them to achieve their best work and found the unit intellectually stimulating. These are good elements of answers to RQ2 on how the assessment benefitted the students. They were also overall satisfied with the unit and found the staff were good at explaining things. This does not account for another outcome: students learned through their research that it is possible to solve global warming. This is certainly the best outcome.

Sharing with policy makers

In terms of sharing with policy makers, I recently have been in touch with members of UK parliament and discussed with them the solution of planting trees and ways to reduce gas emissions. For example, cruise ships account for a large proportion of emissions for an industry which is far from being essential, and a large cruise ship pollutes as much as millions of cars (Vidal, 2016). Cruise ships could be replaced by other activities such as sailing with the wind. Planting a trillion trees is a huge human effort which we must undertake, reforesting forests but also planting in desert areas to use the space. There were once 6 trillion trees on Earth, we can certainly achieve planting a trillion. This article will be shared with policy makers and starts answering RQ3 and so far their reception is positive; they are willing to work on solutions to Climate Change.

Conclusion

In this paper we have shown it is possible to do research in class (RQ1) even on difficult topics as Data Science and Climate Change. We have proposed an assignment and given examples of students' answers. We looked at the unit survey which exhibits that students were challenged by the assignment and the success rate of 97.5% shows the interest in the topic (RQ2). We discussed next steps in informing policy makers (RQ3). This paper raises awareness on Global Warming issues and motivates the solution of planting trees in large numbers and reduce gas emissions. Initiatives such as the great green wall (Great Green Wall, n.d.) and the trillion trees projects (Trillion Trees, n.d.) encourage us to contribute.

Acknowledgements

I would like to particularly acknowledge the 45 students who took part in this year's Data Science class.

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DIGITAL TECHNOLOGIES IN PRESCHOOL TEACHER WORK TEAMS' USE OF SHARED ACTIVE SCREEN

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Abstract

This paper explores the possibilities and challenges related to the use of Shared Active Screen (SAS), from the preschool teacher work team perspective. Using learning reflections, seven work teams reflected upon the possibilities and challenges related to the use of SASs. The work teams saw challenges related to accessibility, time and professional development. Possibilities were the use of SASs in curriculum-based teaching activities and involving the children in collaborative learning activities. How preschool teacher work teams develop the use of SASs over time in their teaching activities with preschool children will be important for supporting children's learning with digital technologies.

Introduction

Information and Communication Technology (ICT) for teaching and learning continues to increase in schools. This is also true in the preschool context in Sweden, where tablet use in preschools for small children continues to rise (Fridberg, Thulin & Redfors, 2017; Marklund & Dunkels, 2016; Otterborn, Schönborn & Hultén, 2018). The Organisation for Economic Co-operation and Development [OECD] (2017) has high intentions for ICT regarding early childhood education and providing foundations for skills, development, well-being and learning. This is in line with Swedish preschool curriculum development since 2010, in which technology use is strengthened (Swedish National Agency for Education, 2016). In July 2019, a revised version of the preschool curriculum with an increased emphasis on understanding digitalization will be implemented (National Agency for Education, 2018). This involves increased focus on and expectations for preschool teachers' use of digital tools in general (Strawhacker, Lee, & Bers, 2017).

Sweden is seen as having a high level of access to ICT, including access to the Internet of 96.4% of the overall population in 2015 (Internet World Stats Usage and Population Statistics, 2018). Even very young children have a high level of Internet access and use. For example, 79 % of 2-year olds, 93% of 3-year olds and 96% of 4-year olds have access to the Internet (Statista, 2018). This high level of access and use could be expected to be related to access and use in the home and therefore is acknowledged in preschool (Palaiologou, 2014). Although ICT access has increased significantly in Sweden during the last few years, efforts are not as evident in learning and teaching activities (National Agency of Education, 2016).

Use remains at the same level, and teachers lack ICT support, equipment and professional development (National Agency for Education, 2016). This has led to recent changes in the curriculum to meet the need for digital competence in schools among students, teachers and school leaders (National Agency for Education, 2016).

One of the most important tasks for preschools is compensating for socio-economic differences that may impact children's development and learning. Equality of access to digital technologies has also been a concern (Sherlidan & Samuelsson, 2003). In the school context, digital inequity has been difficult to address, and there are differences within schools and between schools (Håkansson Lindqvist, 2015; Grönlund, 2014. One reason has been issues related to implementing digital technologies in teaching and learning activities (Samuelsson, 2014). At the same time, there appears to be a gap between accessibility and teachers' use of digital technologies in teaching and learning activities (National Agency for Education, 2016a).

Digital Technologies in the Preschool Context

The use of digital technologies in preschools appears to be a relatively new phenomenon (Hernwall, 2016). Parents and teachers are optimistic regarding children's use of digital technologies (Sandvik, Smørdal, & Østerud, 2012; Mertala, 2017) and see possibilities for learning (Björk Guðmundsdóttir & Hardersen, 2012; Moinian, 2011). Digital technologies may be supportive for children with special needs (Burke & Hughes, 2017) and for children with memory difficulties (Drigas, Kokkalia, & Lytras, 2015). Tablets can, for example, create a good environment for play, exploration and experimentation (Moore & Keys Adair, 2015). The inclusion of ICT with ICT-adapted teaching approaches may also support literacy (Bajovic, 2018; Neumann & Neumann, 2014), mathematics (Sandvik, Smørdal & Østerud, 2012; Vernadakis Avgerinos, Tsitskari, &, Zachopoulou, 2005) and social activities (Lawrence, 2018). Lindahl and Folkesson (2012) observe that ICT is considered useful in preschool for supporting children in becoming democratic citizens, as well as becoming active and competent citizens. Further, many parents feel that introducing ICT in preschool is useful for preparing children for the future (Plowman, Stevenson, Stephen, & McPake, 2012). Plowman and Stephen (2007) suggest that ICT could be used for children's independent play-based learning (Beschorner & Hutchison, 2013), but this appears to be difficult to achieve. Other researchers note that ICT may hinder social interaction between peers (Cordes & Miller, 2000). Thus, collaborative work is of importance in working with technology as an educational tool (Drigas et al., 2015; Mertala, 2017). Teachers' perceptions of ICT and confidence in using ICT are also seen to be important (Nikolopoulou & Gialamas, 2015). Although preschool teachers play an important role in teaching children with the use of tablets, teachers and children may have different intentions and aims (Nilsen, 2014), for example didactics or entertainment (Petersen, 2015).

A digital tool that supports collaborative work and cooperation is the Shared Active Screen (SAS). The SAS is an oversized, portable tablet with which a teacher works together with a small group of children. Teaching activities with SASs provides opportunities to support collaborative work with children (Travers & Fefer, 2017) and appear to enhance individual work, offering guidance "by providing a dynamic digital environment where users can interact with content and each other in tandem" (Travers & Fefer, 2017, p. 52). With the increased use of tablets in the preschool context in Sweden (Nilsen, 2014; Petersen, 2015), there is a need for research on how teachers work to implement digital technologies such as SASs, developing and designing their teaching and learning activities and learning collaboratively to support children's learning. Preschool teachers' teaching methods and design for supporting small children's use of technology appear to be important (Kjällander & Moinian, 2014; Selander & Kress, 2010). This also involves developing ways to reflect upon practice (Marklund & Dunkels, 2016).

Otterborn, Schönborn, and Hultén (2018) report results that show a high level of engagement with digital tablets in preschools in a variety of teaching and learning activities, such as subject-related activities, programming and problem solving. These researchers mean that opportunities for meaningful teaching and learning activities are evident, despite challenges such as increasing expectations and a lack of digital skills. When asked to give recommendations, the teachers provide recommendations regarding clearer curriculum guidelines for use and the need for professional development (Otterborn, Schönborn, & Hultén, 2018; cf. Håkansson Lindqvist 2015; Vrasidas, 2015 in the school context).

Purpose and Aims

The aim of this paper is to explore, describe and analyze the possibilities and challenges related to use of digital technologies, more specifically SASs, in the preschool context from the preschool teacher work team perspective. The following research questions are hereby put forward: a) how can the work with SASs in the preschool teacher teams be described?; b) what possibilities and challenges do the preschool teacher work teams perceive in the work with SASs?; and c) using the Ecology of Resources Model (Luckin, 2010) and the theoretical concept of filters, how can these possibilities and challenges be understood as teaching, learning and collaborative professional development activities? This paper aims to contribute new insights in the use of SASs in the preschool context, as the initial study in a research project studying the use of SASs and the conditions for collegial learning and professional development for preschool teachers, preschool teacher work teams and preschools as organizations.

Theoretical Framework

The Ecology of Resources Model (Luckin, 2010) will be used as a theoretical framework. The possibilities and challenges that preschool teachers in work teams perceive regarding SASs will be analyzed using the resource elements *Environment*, *Knowledge and skills*, and *Tools and people* and the theoretical concept of *filters* (Luckin, 2010). The model illustrates how learners have access to these resources and how filters may restrain or impede the learners' access to the resource elements. Therefore, by identifying filters, it is possible to alleviate the filters and widen access to the resources to a greater extent. In this paper, the "learners" are seen as members of the preschool teacher work teams on an aggregated level.

Method

In order to study preschool teacher work teams' perceptions of the work with SASs, data were gathered from learning reflections inspired by Moon's (2006) method of learning journals. In the learning reflections, the preschool teacher work teams were asked to reflect upon the work with SASs at present and their thoughts on how to develop the work with SASs through project work. They were also asked to reflect upon the possibilities and challenges with this work as well as the support they expected would be necessary in order to advance the work with SASs. The learning reflections were completed during a planning day for the preschool in August, 2018. The preschool is located in a smaller city in the northern part of Sweden. At the preschool, there are approximately 155 children. Prioritized work areas at the preschool during 2018-2019 are teaching and the new curriculum; ICT; and creating a safe and beneficial learning environment. The preschool is organized into three departments with seven preschool teacher work teams, and 3-6 teachers per work team. In this study, the learning reflections are presented and identified within seven work teams (WT1-WT7). In the analysis, data in the form of free text comments were coded and categorized (Hjerm & Lindgren, 2010). Thereafter, the codes were analyzed and placed into broader categories. These categories were analyzed using the Ecology of Resources Model (Luckin, 2010).

Results

In this section, the results of this initial, qualitative study are presented according to the following categories: *state of the work with SASs at present; developing the work with SASs; possibilities* and *challenges*. Work team comments have been translated by the author into English from the original Swedish.

State of the work with SASs at present

When asked to reflect upon the state of the work at present, the work teams report different levels of use as well as a wide variety of uses of SASs to support pedagogical activities. One work team states that it had "had the SAS only a few times" (WT1). Another work team connects this to access: "Since the accessibility has been limited, we have only used it a few times" (WT6). Other work teams appear to use the SASs more frequently: "We use it more continuously, as a natural part of our work" (WT1), while use in other work teams was limited:

"Right now, we are not working with SAS" (WT6). The use of SASs to support pedagogical activities appears to be widespread. One work team reports using SASs "in our Christmas calendar, parent meeting and as a projector" (WT1). Other work teams report other activities: "The children have drawn on it in pairs and practiced collaboration. In the theme about me, we used feeling apps and the children did different tasks" (WT3); "In gatherings, we have explored content together with the children" (WT4); "We watch instructional videos and have used Activinspire, have listened to music and movement play" (WT5); and "To vote, show things, take attendance, teaching" (WT7). Overall, the work teams describe using SASs as a "supplement to computers and tablets" (A5) and that it is "fun but difficult, more input is needed" (WT6). At this initial stage, one work team sees opportunities: "SASs can have unlimited possibilities with the right conditions and perquisites" (WT4).

Concerning help and support, the teacher teams report the need for technology that works: "The right equipment and equipment that works" (WT1). The work teams also report needing time for testing and trials: "Time to test things by ourselves and to learn different programs" (WT1) and "Time for the work team to test how we can use it [SAS]" (WT6). Support is needed both in more training and in skills: "Supervision and education" (WT3), but also in actual use "To be able to use the SAS more often" (WT2). One work team reflects upon the need for a person who is in charge of the SASs: "We need someone who is responsible who can help, support, present ideas and suggestions" (WT5). One work team reflects on the importance of having someone in charge "who can add new materials… the children are not interested if we always are work with the same things. Then, the risk is that the SAS is used as a very expensive drawing tablet or a dance-screen" (WT4). Other support involved allowing one work team to work more specifically with SASs to inspire and support the work with SASs: "A SAS work team, education and inspiration" (WT7).

Developing the work with SASs

When asked to reflect upon how the work teams could develop the work with SAS, accessibility appears to be key. Here, one work team reports: "We would like every work team to have their own SAS to be able to work with it more often" (WT2). This reflection is confirmed by other work teams: "It [The SAS] has been difficult to book, which is why we are happy that we have our own SAS in the work team" (WT3) and "It [SAS] has to be close by and accessible. This is why it is difficult to use it spontaneously" (WT6). Professional development also appears to be necessary, both for individual teachers and for work teams: "More education and more time to teach ourselves and the work team" (WT5).

For developing the work with SAS, the work teams provide a wide range of development projects, some of which are more in general and some of which are more specific. Some work teams describe opportunities to increase their own knowledge: "We want to increase our knowledge and find more ideas and inspiration about how we can use SAS" (WT2). Other work teams saw development projects as a way to combine SASs and curriculum goals: “The material must be accessible and in themes according to the goals in the curriculum” (WT4). It is also important to follow the work with SASs over time: “To use the SAS every day to see what happens” (WT7). The work teams also see opportunities in more specific development projects with SASs by “involving SASs in our pedagogical theme – our senses. We start with sounds: listen, create our own sounds, etc.” (WT1); “We would like to use the children’s pickids in SAS. We want to use it in gatherings, with singing, exercise and stories” (WT3); “To be able to draw a 3D-drawing” (WT5); and "We want to use it [SAS] with mathematics. Swedish, collaboration, exercise and even for singing and movement” (WT2).

Challenges

For the work teams, the challenges are seen in technical problems, “technical troubles” (WT1) and access to the technology: “A prerequisite is that we have more than one laptop in order to be able to use SAS” (WT6). The issue of access to technology, according to one work team, is a challenge for the work with SASs longer term: “Accessibility is necessary in order for SASs to be a natural part of our work” (WT1). Time is also an important aspect. One work team describes this as: “To have time to prepare and carry out activities when we have many children and too few teachers” (WT3). This involves time for collaboration, planning and reflection: “we must have the time to work together” (WT1) as well as to “have the opportunity to reflect and plan (WT2). Another work team notes a challenge in the need for skills: “We do not have sufficient education” (WT6). Other challenges noted by the work teams are related to the pedagogical challenges: “Finding the right level for children who are 1-2 years old. That they are given challenges based on their age and level” (WT2). Another challenge was seeing, being aware of, identifying and documenting pedagogical processes: “To see different approaches… that we see different processes” (WT5).

Possibilities

In the learning reflections, the preschool teacher work teams report possibilities related to the work with SASs. These possibilities are seen in making teaching activities more transparent and provided possibilities for collaboration: “The activities become clear – visible for all the children and cooperation” (WT1). Another work team expands this idea: “[SAS] makes what we work with much clearer. Stronger effect when you work together with the children and you can see what you are working with” (WT6). SASs as a tool is also seen as a possibility, through learning with the use of an additional tool: “Using different tool to reach the same result” (WT5) and “If it is easily accessible, we see strong possibilities with [SAS] as a digital tool in children’s learning” (WT6). Another work team sees continuous use over time as a way to increase the possibilities to create new uses: “If we can learn how to work continuously with SASs, we will see possibilities for more areas of use” (WT2). Other work teams summed up the possibilities: “[SAS] increases competences for both children and adults” (WT7) and “That we as pedagogues can develop together with the children” (WT6). For the children the preschool teacher work teams report possibilities in SASs through: interest, “Strong interest among the children – engaging” (WT1); and fun, “Fun learning where everyone can see everything at the same time” (WT3) and the children work with “new technology” (WT7). One work team describes this as the possibility to “capture the children through the SAS” (WT2). The work with SASs provides possibilities for the work team to use the SAS as “a tool for the children in their education” (WT2) as well as “an introduction in ICT” (WT5). One work team sees the possibility to provide a pedagogical shift to involve the children: “The children become producers” (WT7). Further, the work with SAS: “Can be connected to the curriculum already in SAS” (WT4). Overall, collaboration between teacher and children is noted: “Increased possibilities for problem-solving, collaboration, cooperation between the children and the pedagogues” (WT6).

For the preschool teacher work teams, possibilities are seen in collegial learning. Beyond describing the work with SASs as “fun” (WT7), the work teams report possibilities in the work with SASs to “Go further in thought and competence” (WT7). This involves new skills in the work team: “Everyone in the work team will learn more about digital technology” (WT3). These skills, in turn, provide beneficial conditions to strengthen the work with SASs in the work team and with the children: “The more comfortable and competent we are the more we can share with/teach the children” (WT1).

Discussion

The aim of this paper is to explore, describe and analyze the possibilities and challenges related to use of digital technologies, more specifically SASs, in the preschool context from the preschool teacher work team perspective. In answering the first research question, the preschool teacher teams describe the work as stimulating, fun and developmental. Different work teams work with SASs to different extents, with some work teams using SASs often, while other work teams are in the initial stages of their work. Overall, the work teams provide an optimistic description of the work at present as well as the work to come. The challenges seen are access to technology, time for planning, preparation, testing and trials. The work teams see possibilities in professional development for themselves and in collaborative work with the children. The possibilities for the children’s learning are seen in collaboration, transparency, and curriculum-based work with the SAS, as well as what the work teams in this study describe as fun work with new technology.

The possibilities and challenges as perceived by the preschool teacher work teams can be analyzed using the Ecology of Resources Model (Luckin, 2010) and the theoretical concept of filters within the resource elements *Environment*, *Knowledge and Skills* and *Tools and People*. In their teaching and learning activities it will be necessary for the preschool teacher work teams to support and expand the use of SASs in their work with the children (*Environment*), promote own skills in SASs *(Knowledge and Skills*) as well as increasing their own use and work with SASs with the children (*Tools and People*).

In the resource element *Environment*, the need for the preschool teacher work teams to support the use of SASs could be said to manifest a filter. While the work teams see many possibilities in the work with SASs for themselves and the children, it will be important that they have continuous access to the technology, in order to create an environment where they advance the use of SASs and their own skills (Håkansson Lindqvist, 2015; Grönlund, 2014). How preschool teachers collaborate and create opportunities to share learning experiences will be of importance for the environment and the work teams' use of SASs for themselves and the children (Drigas et al., 2015; Mertala, 2017). In this resource element, time manifests a filter in several aspects. The preschool teachers as work teams will need time to use and advance the use of SASs in their teaching activities with the children as well as to find, test and evaluate SASs and creating an environment and other digital tools as pedagogical tools (Samuelsson, 2003) for teaching and for play (Moore & Keys Adair, 2015).

In the resource element *Knowledge and Skills*, professional development in ICT as well as SASs will be important (Håkansson Lindqvist, 2015; Grönlund, 2014; Otterborn et al., 2018) in order for SASs to become a natural part of the work with the children. This involves making the use of SASs continuously, in order to test and explore new uses, according the teachers in this study. In this resource element, the knowledge and skills relate to the use of SASs as well the possibilities to link the use of SASs to the preschool curriculum could be said to manifest a filter. Teachers need time to learn and increase their skills, perceptions and confidence in using SASs in order to support the children's learning (Nikolopoulou & Gialamas, 2015). As reported by one work team, this may take place both individually and in collaboration with other teachers. In this study, a large variation between use and skills in SASs in the work teams can be seen. Therefore, preschool teachers' skills as collective knowledge can also be said to manifest a filter in this resource element. This involves supporting the skills in the work teams in the balance between technology and pedagogy, if the use of SAS, as reported by one work team, is to go beyond using the SAS as a tablet or dance-screen, and the teachers can utilize their knowledge and skills to balance their different aims in use (Nilsen, 2014). Increasing teachers' own use of SASs will most likely provide possibilities to increase children's use as well as increasing the use of SASs in the work team and in the preschool. In this resource element, the exchange of skills and experiences with SASs could be said to be an additional filter. If the work teams are given the opportunity to share their skills and experiences, through different channels such as online forums, planning and meetings to share these experiences, the use of SASs will most likely be supported.

The technical challenge of not having access to SASs or laptops can be considered to manifest a filter in the resource element *Tools and People*. In this resource element, accessibility is the most important challenge that can be said to manifest a filter. Access to SASs will be important if the technology is to become implemented, integrated and accessible for all (Samuelsson, 2014; Sherlidan & Samuelsson, 2003). Beyond technical challenges, the preschool teacher work teams in this study see the need for a work team that focusses on SAS, or the need for an expert. How these support functions are solved can also be seen as a filter (People). These support functions will most likely be important in supporting the work with SASs by efficiently providing new information about SASs and pedagogical activities with SASs, as well as providing the inspiration to work with SASs. This support will most likely involve design (Kjällander & Moinian, 2014; Selander & Kress, 2010) and reflection upon the use of these tools in practice (Marklund & Dunkels, 2016).

One of the most interesting findings in this study is the preschool teacher work teams' perceptions of the possibilities for future work with SASs. Despite challenges regarding technical issues, accessibility and lack of time, there appears to be both the interest and initiative to continue and expand the work with SASs with the children. Developing the work with SASs, according to the preschool teacher work teams in this study, could promote beneficial conditions for digital skills, curriculum-based teaching activities and collaboration among the children. How beneficial conditions for preschool teacher work teams work with SASs can be created to support children's learning will be of importance to study from the perspective of digital equity.

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TECHNOLOGICAL TEACHING MATERIAL IN SCIENCE CLASSES OF GREEK ELEMENTARY SCHOOLS

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Abstract

This paper aims to examine the integration of technologically oriented instructional material in elementary science in Greece. Such material is justified by research to assist science teaching. Whether teachers decide to use it depends on their knowledge and perceptions around teaching generally, the subject they teach and ICT. Based on these findings, this research study was designed aiming to show which materials teachers prefer to use in their work. This has not been thoroughly examined by research so far. Through observations and statistical analysis, the research draws conclusions about teachers' selections and suggests ideas for further projects.

Introduction

This research focuses on the field of technological instructional material in the subjects of science, in the context of Greek Education. It is necessary to look into the basic theoretical points of these basic and well-studied topics. The main concept that has to be negotiated and analyzed is the one of instructional material. There should be particular emphasis on the integration of instructional technology with regards to teaching science at the elementary school level. This can be done by reviewing how it is being used in tasks related to teaching or learning and what conclusions are drawn by research about it. Since the research focuses on the Elementary Educational system of Greece, these characteristics have to be considered as well (Cohen, Manion, and Morrison, 2011).

The term 'instructional material' refers to means of communication, dissemination, interaction and discussion that educators can use during teaching in order that learners benefit from the instruction. The use and effectiveness of instructional materials is based on the fact that communication among educators and learners is considered to be a very complex, multi-dimensional and bidirectional topic. The nature of this communication has a significant role in the effectiveness of teaching. Both educators and learners are expected to participate actively in the learning process so that they assist by sending and receiving messages and information, which will help the construction of knowledge, the skills to be developed and the attitudes to be adopted (Amadioha, 2009; Tyler, 2013).

Mostly instructional materials refer to tangible objects that are used either by the teacher or the learner. The interaction of the learner with the material can have a significant impact on the teaching outcome. There are various types of teaching materials, as well as various categories. A common categorization is among the conventional ones, such as the text-book, whiteboard, spreadsheet, and photocopies. There are however the technologically oriented ones, such as computers and projectors, interactive whiteboards, audiovisual material, software and websites (Hora, Oleson & Ferrare, 2013; Hora, 2015).

Literature Review

The Science subject, according to the contemporary approach of the Next Generation Science Standards, aims to help learners to: develop and use models; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; construct explanations and design solutions; engage in argument from evidence; and obtain, evaluate and communicate information. These standards relate to topics such as data searching, analyzing, communicating, exchanging information and constructing knowledge (NGSS, 2013).

Bell, Davis & Linn (1995) support that ICT generally can assist science learning, which is often challenging for learners, as it is related to abstract ideas and concepts, sometimes outside their everyday experience. Integrating with ICT can help teachers give a deeper understanding of science as a dynamic field of on-going development and not a static body of knowledge. In addition to that, Linn, Mattuk, and Gerard (2016) state that ICT can assist inquiry learning, which is compatible to contemporary approaches to science teaching that emphasizes in the importance of inquiry, experimentation and investigation.

Mishra & Koehler (2016) stress the importance of the Technological Pedagogical Content Knowledge that teachers need to develop in order to include ICT in their teaching. This term encompasses knowledge about pedagogy, teaching, the subject matter, such as science and the potential of ICT applications, including technological teaching material. Teachers therefore need the appropriate background or training, in order to understand what types of technological material exist, which fit the content they have to teach, which can be used and how they can be adjusted to the context. Investigating integration of ICT in science teaching through the prism of technological pedagogical content knowledge expands in various dimensions. Three of them are: appreciating why to use ICT; understanding specific benefits of ICT application and technological instructional material; and knowing how to implement it in classroom (Bell at al, 1995; Linn et al, 2016).

With regards to the first dimension, Webb (2005) has pointed out four advantages. First, the extension of learners' experiences, information and evidence with science topics which they might negotiate. Second, through appropriate research approaches such as inquiry and experimentation, it is possible for learners to develop skills such as data collection and analysis, which can help them construct knowledge and solve problems. Third, similar tasks are expected to promote skills, such as designing solutions, research, communicating and critical thinking. Fourth, all these factors can assist healthy cognitive development and model designing.

With regards to the second dimension, there are benefits from technological instructional material in science teaching. Computers and projectors may help teachers present their material to learners. Interactive whiteboards give broad opportunities for interaction in the classroom and use of multimedia. Audiovisual material may be a good supplement to textbooks in explaining further the information and points negotiated. Education software, such as simulations, can offer opportunities for learners and teachers to experiment even in contexts outside the learners' every day experience. Such contexts could be outer space, nuclear reactions and microworlds that would otherwise be difficult or even dangerous to use in classrooms (Law, 2009; Fokides & Mastrokoukou, 2018). Importantly, the internet can be used as a tool for gathering information and resources (Eady & Lockyer, 2013; Hora et al, 2013; Hora, 2015; Linn et al, 2016). Each of these advantages can be associated with different Science Standards (NGSS Lead States, 2013).

With regards to the third dimension, the teacher's decision to eventually use technological instructional material, in their actual work this is neither simple nor straightforward. This complexity usually derives from factors mediating in lesson planning (Uluyol & Şahin, 2016; Comi, Argentin, Gui, Origo & Pagani, 2017). Mueller Wood, Willoughby, Ross & Specht, (2008) when carrying out research in secondary education contexts, have tried to identify such factors. These were: teachers' comfort with computers, including ease and enthusiasm generally; teachers' use of computers in terms of frequency for any occasion, either personal or professional; teachers' training and knowledge on computers; teachers' attitudes towards computers and technology either as a learning or motivational tool; teachers' past experience of using their computers, including whether they have been helped or disappointed by it; teachers' general ideas about their teaching work and whether computer use is compatible to it; the general context where teachers work, including curricular demands, availability, legal issues or pupils attitudes; the actual topic or subject teachers aim to teach. These conditions are linked to the general context, where teachers work. Webb (2005) suggests that the interaction between the teacher factor, which encompasses beliefs, ideas, and pedagogical reasoning, and the wider context factor is what defines the affordances of ICT use in the classroom, along with the selection to use technologically oriented instructional material.

Therefore, the teacher's decision has to do with developing an appropriate relationship with ICT, relating its use to Science Standards that are to be achieved (NGSS Lead States, 2013), as well as linking to the general working conditions where teaching takes place (Law, 2009; Uluyol & Şahin, 2016; Fokides, 2017). In other words, the integration of ICT depends on how qualified teachers are with regards to pedagogy, technology, subject matter, and teaching practices (Linn et al., 2016). Limited is the research to identify exactly what types of instructional technology is actually being used in the classroom. In fact, this limited research focuses mostly on secondary or higher education. This actually stresses the rationale for particular research that focuses on elementary schools, in a specific educational context (Mueller et al, 2008; Uluyol & Şahin, 2016). Such research can give crucial evidence on the technological pedagogical content knowledge that teachers need to possess (Mishra & Koehler, 2016).

Methodology

This study took place in the context of the Greek Education System and was focused on three basic research questions, drawn from the literature.

Science in the Greek Education System

The Greek elementary school addresses pupils from the ages of 6 to 12 and is completed in six grades. Science topics exist in each one of the six grades. However, science is not a discrete subject in the first four years, where it is a major part of a subject called 'environmental study'. This includes geography and social themes. In the higher grades, the fifth and the sixth, science becomes a separate subject. It is taught for 3 sessions of 45 minutes per week. The topics taught in science are states of matter, mixtures and solutions, energy, heat, electricity and magnetism, mechanics, sound, light plants, animals and anatomy of the human body (Greek Ministry of Education, Research, and Religious Affairs [GMERRA], 2011).

The Greek Education system has been identified by the Organization for Economic Co-operation and Development [OECD] (2017) as a highly centralized system, especially at elementary and secondary education levels. This identification is based on the fact that many decisions about actual teaching are arranged at the level of the Greek Ministry of Education, restricting the initiatives and decision making of schools and teachers. In science, as with every subject in Greek primary and secondary education, a teaching package is distributed to teachers, who are expected to use it. This includes a teacher's book, with pre-designed lesson plans for the teacher as well as basic teaching instructions, the learners' book with subject matter, and the workbook which includes worksheets and experimental activities for learners to work through and construct knowledge. Unlike other subjects, where the basic axis of instruction is the pupils' book, in science, teachers are expected to use it mostly for reference. It is mainly the workbook that science instruction should be based on.

The elementary science curriculum suggests opportunities for teachers to use technological types of instructional technology in various activities (GMERRA, 2011). This can help stressing the potential of technological material (Tyler, 2013). The teachers' book also mentions indicative examples in various lesson plans. In fact, appropriate sites provide the teaching packages in digital form, where they include the texts and worksheets that the teachers can also use print (GMERRA, 2011).

The Research Questions

Having described the research context, in order to investigate the integration of technological instructional material in the science classroom, it is important to define relevant research questions. The definition and precision of the questions depends on the main theoretical points around the subject, as they are formed by the literature (Webb, 2005; Eady & Lockyer, 2013; Comi et al, 2017; Linn et al, 2016; Fokides, 2017). It is these questions, thereafter, that will assist in defining, according to their type and content, what method and approach of analysis fits for accurate and useful findings. Having in mind the above, the research questions are formed as follows:

1) What technological instructional types do teachers in elementary science classes use generally?
2) Is there differentiation among those types?
3) Is there differentiation between the types used in the fifth and the sixth grade?

These research questions can give insights into whether the teachers are familiar, appreciate and implement such instructional types in science class, which in turn can give information on their technological pedagogical content knowledge (Mishra & Koehler, 2016).

The Data Collected

Having stated the research questions, it is now important to plan the appropriate methodology to answer them. This includes sampling, planning data collection and data analysis (Cohen et al., 2011).

This research examined a sample of 80 elementary teachers, working in schools on the island of Rhodes. Half of them were in the fifth and the other half in the sixth grade. The data collection was completed by observing science lessons, as this specific data collection approach was found to be the most appropriate, bearing in mind the scope of the research (Cohen et al., 2011). Two science sessions of each teacher were watched. This means there were 80 sessions in the fifth and another 80 in the sixth grade. During the observations, any technological instructional means used was recorded, along with the amount of time of use, in minutes. This could be the interactive whiteboard, the internet, simulations, Web-sites and audiovisual material.

This recording was helped by a predesigned form. This form had divided the 45-minute session into nine intervals of five minutes. In the boxes of the form, which were corresponding to intervals, the types of instructional material used were noted and coded. It should be noted that it was possible for an interval to contain two different types of instructional material. For example, it is possible for a teacher to use within the same five-minute interval a website of information and simulations. It is also possible for a teacher to use no instructional material, either technological or conventional, within a specific interval (Eady & Lockyer, 2013; Hora et al, 2013; Hora, 2015). Since each session lasts for 45 minutes, which means nine intervals, the total number of intervals observed was 720 for each grade, or 1440 in total.

After the data collection was completed, analysis followed. Analysis was planned to be based on a statistical comparison between the recorded data of the fifth and the sixth-grade observations. This comparison was selected as appropriate to give insights into any common or differentiating points concerning the use of technological instructional materials by teachers. This analysis used Microsoft Excel and SPSS.

Firstly, the number of intervals that each type of instructional material was observed was noted in the Excel file. This led to the calculation of the sum, the frequencies, as well as the average of intervals in each grade. This helped further statistical analysis that was to follow. More specifically, for the first and the second research questions, the findings were based on descriptive statistics. For the third research question, the findings derived through calculation of the chi-square factor and standardized residuals. The standardized residuals serve as criteria to justify if there is any statistically significant differentiation, which is evident when they have a value equal to 2, or greater (Swift & Piff, 2014).

Data Analysis

With regards to the first research question, the completed observations completed showed that there are various types of technological instructional materials used in science classes, in both grades. As seen in the number of intervals and the average, which are shown in Table 1, teachers in the classes of the sample used computers, projectors, interactive whiteboards, audiovisual materials, software and the internet. This likely can be attributed to the fact that teachers are familiar with the use of such materials in their work and understand that their use has benefits for science classes. Moreover, the use may indicate a certain level of familiarization on behalf of teachers with technological means and their educational use (Mueller et al., 2008; Uluyol & Şahin, 2016). In combination with that, it may be due to the support of the wider context and the curricula, both at the level of ideas and theory as well as the level of facilitation in implementation in the actual teaching practice (Law, 2009; GMERRA, 2011; Uluyol & Şahin, 2016; Fokides, 2017).

Overall, the number of intervals where technological instructional types were used is a rather small portion of the total observed: the total number of intervals observed as a percentage of the total was only 28% in the fifth grade and 33% in the sixth. This might be attributed to the highly centralized character of the Greek Education system, which encourages teachers to abide by the distributed teaching package, the text book and teacher's book (OECD, 2017). The promotion of ICT through the teaching packages does not seem to encourage teachers to detach from conventional teaching means and instructional types (Law, 2009; Uluyol & Şahin, 2016).

Table 1

Numbers of intervals of use of technological instructional types and percentage of the total, N=720

Instructional Types	**5th grade, N=720**		**6th grade, N=720**	
	Intervals	**Percentage**	**Intervals**	**Percentage**
Computers and Projectors	92	12.78%	138	19.22%
Interactive whiteboard	94	13.00%	72	10.00%
Audiovisual material	10	1.44%	14	1.89%
Education software	4	0.56%	10	1.33%
Internet	4	0.56%	7	1.00%
TOTAL	204	28.33%	241	33.44%

With regards to the second research question, the numbers show that computers and projectors along with the interactive whiteboards are more used than other technological instructional materials. Comparatively, the first two types are observed to be used more frequently compared to the rest. This trend is rather obvious in both grades. It may be that the teachers tend to use the digital form of the textbook and the teaching package. This can be attributed to their dependence from it, due to the centralized character of schools (GMERRA, 2011; OECD, 2017).

This general trend might be attributed to the compatibility of the specific types of instructional technology to the teaching practices and approaches of the teachers. In other words, teachers might find these types easier to implement in their planning and teaching instead of the others (Webb, 2005; Eady & Lockyer, 2013; Fokides & Mastrokoukou, 2018). Teachers may consider, for example, that the interactive whiteboard is more useful or easy to use in the classroom than education software, which they may think may divert slightly from the actual goals they want to achieve. This might indirectly relate to the structure of the lesson plans and their goals, as they are prepared and distributed centrally (GMERRA, 2011), addressing again the character and uniqueness of the specific context (OECD, 2017).

Lastly, in what concerns the third research question, as shown from the standardized residuals, there is no significant difference between the two grades. The value of the residuals, as demonstrated in Table 2, does not exceed the number 2, in any of the category variables, which would show significant difference statistically. Aside from that similarity is the greater picture of the values. The chi-square statistic is 12.1161. The p-value is 0.016508. Statistically, this result is significant at $p < 0.05$ (Swift & Pift, 2014). Overall, therefore, there seems to be a correlation between the two grades, which can be justified as they are consecutive years of the higher grades of elementary schools, guided by a similar curriculum. Any difference in the units taught might not be so great as to lead teachers to an alternate means of preferred technological instruction (Law, 2009; Uluyol & Şahin, 2016; Comi et al., 2017).

Table 2

Intervals of use of technological instructional types and standardized residuals

Instructional Types	**5th grade intervals**	**6th grade intervals**	**Standardized Residuals**
Computers and Projectors	92	138	-1.73
Interactive whiteboard	94	72	1.73
Audiovisual material	10	14	-0.25
Education software	4	10	-0.40
Internet	4	7	-0.28

Overall, the use of technological instructional material is not frequent. This applied to both the fifth and the sixth grades. Among the types used, the computers and the whiteboard seemed to be used more frequently than others. With regards to the technological pedagogical content knowledge, the findings show that probably these types were considered to be more compatible to the teachers' practices, ideas and conditions of work (Webb, 2005; GMERRA, 2011; Eady & Lockyer, 2013; Linn et al., 2016). There may be an issue of availability (Fokides, 2017). Teachers may lack appropriate background and professional development (Mishra & Koehler, 2016), or the policy, regarding curricula implementation is not so effective (Tyler, 2013).

Conclusions

This research aimed to give insights to the use of technologically oriented instructional types in the science classes in the higher grades of Greek Elementary Schools. Computers, projectors, interactive whiteboards, audiovisual material, software and the Internet are generally justified for science teaching (Amadioha, 2009; Eady & Lockyer, 2013; Linn et al, 2016). This applies generally to each subject and specifically to science class, where ICT oriented instructional types are found in research to promote knowledge acquisition, skill development and attitude adoption, which are important to science teaching (Law, 2009; Uluyol & Şahin, 2016).

Research has drawn a list of factors that influence the teachers' decision whether or not to use these types in teaching. The integration of ICT in science teaching depends on and reflects teachers' technological pedagogical content knowledge, which relates to teachers' background in pedagogy, ICT familiarization, and knowledge of the subject taught (Mishra & Koehler, 2016). This generally influences teachers' attitudes and ideas, and the way the manage or interact with the wider school and educational context (Eady & Lockyer, 2013; Comi et al., 2017; Fokides & Mastrokoukou, 2018). Limited though is the research that has identified how frequently teachers use these types of technological materials in teaching. This is the rationale of this study.

Within this research, elementary school teachers were observed, while teaching science. During the observations, the frequency that technologically oriented instructional materials used, was recorded and analyzed. Analysis was of a based on descriptive and inferential statistics (Cohen et al., 2011; Swift & Pift, 2014). The main findings were that overall, there was limited use of these types. These data indicate that there is an existent yet rather restricted integration of ICT in the science subject on behalf of the teachers. This integration might call for further development of teachers' ability to involve technological material in the science classroom by relating it to the standards (NGSS, 2013). In other words, teachers need to be assisted to enhance their knowledge and skills in that matter (Linn et al., 2016). Any attention to the teachers' background in pedagogy, ICT, science teaching and integration, which are dimensions of their technological pedagogical content knowledge, should focus in that direction (Mishra & Koehler, 2016).

Before generalizing these conclusions, though, it is important to mention that this research focused on a specific sample of a certain area of schools in Greece. It would be interesting to benchmark these findings with other projects with greater samples, as well as with the opinions of teachers (Cohen et al., 2011).

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IT'S ALL ABOUT THE MIDDLE: PLACING A PEDAGOGICAL FRAMEWORK AT THE CENTER OF PRACTICE IN STEM EDUCATION

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Abstract

The Organisation for Economic Co-operation and Development (OECD) suggests that education reform initiatives in Science, Technology, Engineering and Mathematics (STEM) will require substantive changes in how these disciplines are taught at school and in teacher education institutions. In this paper I take up these challenges by examining how a longitudinal research study in six Australian primary schools supported changes to middle leaders' classroom practices in teaching and learning. The findings demonstrate how a pedagogical framework positioned alongside professional development and working with an academic partner in a process of action research is effective for teacher professional learning in STEM.

Introduction

The lack of focus on STEM education continues to be discussed in tertiary and school education circles and in the mainstream media in Australia and globally (Thibaut et al., 2018). Education jurisdictions are charged with raising national productivity using measures like GDP in their countries because of a perceived 'STEM drain' and declining standardized test scores in PISA and TIMSS[1]. It often seems that every person in the business world, in politics, and on social media has an opinion about and a solution for STEM education (Berry, 2018).

Both the National Research Council (2012) in the United States and the OECD (2012) suggest that reform initiatives focusing on STEM will require substantial changes in how the four disciplines are taught not only in schools but also in preservice teacher education courses in universities (Timms, Moyle, Weldon, & Mitchell, 2018). Multidisciplinary, interdisciplinary and transdisciplinary approaches to STEM when combined with technology-enhanced learning provide rich support to students at school, and may lead to increasing the numbers of graduates in the four disciplines in post-school education (National Academy of Engineering and National Research Council, 2014).

In this paper I take up these challenges by examining how a longitudinal research study in six Australian primary schools supports changes to middle leaders' practices in STEM teaching and learning using action research as an approach to professional learning at two professional development Sharing Days. The study uses a pedagogical framework for technology enhanced learning known as HPC or *High Possibility Classrooms* (Hunter 2013; 2015). This pedagogical framework for teaching and learning was developed from research into exemplary teachers' knowledge of technology integration in classrooms in Australian schools and builds on the work of TPACK (Mishra & Koehler, 2006). Table 1 shows the five conceptions and 22 underpinning themes of the HPC framework.

Table 1
The five conceptions and 22 underpinning themes of the HPC framework

Theory driven technology practice	**Creativity for learning through technology**	**Public learning through technology**	**Life preparation using technology**	**Contextual accommodations using technology**
Technology drives the construction of learning	Technology boosts creativity	Technology scaffolds performance	Technology operationalizes the real world	Technology remains personal and professional
Technology enhances purposeful teaching	Technology creates opportunities for production	Technology enhances outcomes	Technology gives voice	Technology changes time
Technology focuses planning	Technology unleashes playful moments		Technology means ownership and possibility	Technology nurtures community
Technology enriches subject matter	Technology supports values		Technology reveals effectiveness	Technology defines the game
Technology promotes reflective learning	Technology differentiates learning			
Technology shifts conversations and thinking				
Technology engages students in authentic ways				

Note. Copyright Jane Hunter (2015)

Definition of Terms

Google + community is a collection of online PD resources teachers use as a central tool for discussion with colleagues.

Hardware and software: Technology hardware and software at each research site included laptops, interactive whiteboards, voice recorders, Arduino sets, Makey Makey kits, technology tools such as digital thermometers, digital water-testing supplies, and software applications like Wix and Seesaw.

Middle leaders (ML) in the study were identified by their school principals – they conformed to what Stoll, Taylor, Spence-Thomas, & Brown (2018) define as: "teachers who have a formal role, with responsibilities for a subject, cross-curricular aspect of teaching and learning, social development of students, or for a stage or phase of schooling" (p. 4).

Participant training: Participant training focused on ICT associated with STEM curriculum content. A workshop in the first stage of the study concentrated on the technology integration processes and strategies of the HPC framework

Professional Development (PD) describes structured learning activities for teachers, sometimes one-off but preferably ongoing and well resourced.

Professional Learning (PL) refers to the processes and experiences teachers' engage with in order to develop their practice.

Sharing Days (SD) are PD events for teachers.

STEAMpop is a 'hands on' PD experience that values the intersection between the Arts and STEM concepts.

STEMShare is a kit of digital learning resources that are available for schools to borrow. Each STEM Kit includes robotics, 3-D printing, coding, filmmaking, and virtual-reality equipment.

The Structure of the Paper

There are three sections to the rest of this paper. First, in the background section, I discuss some critical moments in recent years for STEM education in Australian schools and examine some of the claims and ideas for more contemporary approaches to teaching and learning with technology, noting that PL focused on middle leaders is one way to pedagogically prioritize this space. I also say more about how the HPC framework and action research informs effective middle leader development in STEM (Hunter, 2017). The second section details the study design, research question, the methods of analysis, and the results. In the third section, I conclude by discussing how agency can be fostered with a pedagogical framework like HPC to create potent STEM professional learning for teachers.

Background to the Study

Australian schools, like so many others in the world, are taking steps to outline what it takes "to make great teaching of Science, Technology and Mathematics the norm, and teaching a profession of choice" (Prinseley & Johnston, 2015, p. 1). Ways to do this must involve attracting high achievers in STEM to primary school teaching, boosting the rigor of preservice courses in teacher education in universities, and making time for principals and executive staff to focus on leading STEM in their schools (Bybee, 2018). This amplification of the what, where and when attention to STEM should commence is endorsed by the Australian government's 10-year *National STEM School Education Strategy 2016–2026* (Education Council, 2015), whose goals are "to ensure that all students finish school with strong foundational knowledge in STEM and related skills [and] are inspired to take on more challenging STEM subjects" (p. 5). Fulfilling such aims requires not only curriculum change and time for PD, but also funding (Ringland & Fuda, 2018). Keen to make its STEM priority known, the Australian government committed more than AUD 1.1 billion in its National and Innovation Science Agenda (2015).

In a comprehensive literature review of the barriers and supports to STEM commissioned by the Australian Department of Education, Tytler, Osborne, Williams, Tytler, & Cripps-Clark (2008) identified that Science and Mathematics in primary schools are either "not well taught or not taught often enough" (p. 133) and that a long-term strategy would be needed to support teachers of these subjects in Australian primary schools[2]. A key aspect identified in the review was the move away from "transmissive and inflexible pedagogies that dominate primary school teachers' practices" (p. 141). Moreover, Tytler et al. (2008) recommended that teachers would require government support to make the teaching transitions and develop the required skills and conceptual shifts.

As education bureaucracies measure more performative milestones (Comber & Nixon, 2011), it is highly accomplished teachers or middle leaders, frequently described as 'experts', who are responsible for shifting and changing classroom practices (Spillane, 2006). They are often a "buffer and a bridge" (Bennett, Wood, Wise & Newtown, 2007, p. 462) between the principal and other teaching staff. Central to their developing capacity and success at this level is support from the principal and appropriate PD (Edwards-Groves, Grootenboer, Hardy & Ronnerman, 2018). These were features of this study, which give voice to strengthening the role of ML through STEM PD in an academic partnership.

A Pedagogical Framework for Technology-Enhanced Learning and Action Research as Drivers for Teacher PL in Effective Middle Leader Development in STEM

The HPC framework backs an approach to integrating STEM that is project based and uses inquiry learning and design challenges[3]. Through its attention to five conceptions that broaden understanding of innovative pedagogies, it involves the knowledge base for teaching the primary school curriculum. By planning and co-teaching, and the 'deprivatisation of practice', the ML in this study were able to flatten the power hierarchies of their schools to enhance collaboration and leadership at the middle level.

Action research is familiar to those acquainted with the professional learning activities of teachers (Groundwater-Smith, 1988). Kemmis (2011) makes it explicit that critical participatory action research is undertaken: "collectively by participants in social practice to achieve 'effective historical consciousness' … of their praxis as practice – that is a morally informed, committed action, oriented by tradition that responds wisely to the needs, circumstances and particulars of a practical situation" (p. 13).

Within action research, distinctions are made between its technical, practical and emancipatory intentions. It is significant that a commitment to improving practice underlines each of these distinctions and that teacher participation in AR involves feelings of vulnerability as a consequence of critical reflection and self-evaluation. Such reflexive practices align with the notion of 'insider knowledge' that is generated within the school context, in combination with 'outsider knowledge' from an academic partner or external colleague/s who might work together to support, progress, and sometimes challenge the classroom practices of a teacher. These actions together form influential teacher professional learning (Kirkby, 2015).

The Study

The Research Question

Several research questions related to middle level leadership for STEM in primary schools guided the study as a whole[4]. This paper focuses on one of them:
How does bespoke PD at two Sharing Days (SD) build middle leader (ML) capacity in STEM?

Design

The research was a 15-month mixed methods study with 22 ML whose teaching experience ranged from three to 30+ years at six primary schools in two regions in New South Wales, Australia. The sites are government schools with students ranging in age from five to12 years, there are high levels of parent involvement, and up to 61% of students come from language backgrounds other than English. Throughout the study, participants utilised a Google + community to share their learning and resources, ask questions and post student work samples.

Data were collected through a range of methods for the larger study (ML interviews, classroom observations, Stages of Concern Questionnaire as pre and post intervention evaluations); those reported here involved ‘exit ticket evaluations’ from the two SD for the study participants held at the academic partner’s university in the second and third stages of the research. The SD gave the ML an opportunity to engage in PD that facilitated sharing progress and practice.

Methods of Analysis

Data were analyzed in three steps: (1) notes were taken during the SD were coded into themes using NVivo 11 (2) these themes were triangulated against plans/policy/school documents; and (3) the SD evaluations (or ‘exit tickets’ accessed by the ML in Google forms). All participants (N = 22) completed online evaluations at the end of each day; 100% attendance on both days.

Results

The SD were held approximately four months apart. On both days, hands-on learning experiences from STEAMpop and the STEMShare programs were key features of the PD: STEAMpop on Sharing Day 1, and STEMShare on Sharing Day 2. There was also a tour of the university’s data arena. Dominant themes in the data are presented in Tables 2 and 3, with relevant verbatim comments from the participants quoted.

Table 2
Findings from Sharing Day 1

Questions	**Responses**
1. What did listening to each other’s presentations at the Sharing Day mean to you?	Dominant responses mentioned positive feelings of interest in what other schools were doing, the benefit of listening to colleagues, the support or validation it gave to the approaches adopted. Seeing more examples of HPC and STEM in action “really helped.” HPC is a scaffold “that although it has teaching strategies that involve technology it gives us a way to talk about what we need to do in the content areas of STEM.”
2. What was the most important part of the Sharing Day?	Finding out that “explicit teaching still needs to be embedded” and seeking ways to “declutter programming” was necessary. Direct instruction preferably takes place alongside group processes in, for example, a [problem-based learning] approach. Some teachers wanted whole school changes that required school executives to agree to “the adoption of whole school curriculum transformation.”
3. How would you describe the session given by the Women in	88.3% of participants said it was informative.

Questions	Responses
Engineering and IT at the author's university?	
4. Would you like to contact STEM experts like Dr XX?	76% of participants said yes.
5. Would you like to hear from other STEM and HPC teachers, for example, YY from ZZ Public School?	78% said either excellent or very useful. They liked hearing about: "flexible programming"; the "*Masterclass* idea to teach specific concepts". Often it was about: "the scale of projects because they allowed students to integrate many outcomes", "community involvement beyond the classroom", doing "longer or shorter units of work (not always 10 weeks)" and "using a *Shark Tank* pedagogy for sharing and showcasing student work".
6. Was the STEAMpop workshop informative?	76.5% of participants said yes.
7. Was the Data Arena Tour useful?	76.5% thought the tour was either excellent or very good.

Table 3
Findings from Sharing Day 2

Questions	Responses
1. What did listening to each other's presentations at the Sharing Day mean to you?	Dominant responses mentioned very positive feelings towards the variety assessment types that could be used with STEM – in particular formative assessment strategies. It was an opportunity to gather "fresh ideas" to take back to their own school. For example: "I really understand HPC better now and that will move me from focusing on what I am doing to what the students are doing."
2. What was the most important part of the Sharing Day?	Finding out that "integrating multiple KLAs was possible," especially into literacy lessons, allowing for "failure in a safe place," not setting the agenda for "what product should be created, keeping projects small". Getting answers to questions about: "how to best support young people to become autonomous, to inquire, problem solve and cooperate with another" – all the while "pondering how to effectively assess the soft skills" and "the need for flexible dynamic programming with multiple entry points for learning and sharing knowledge."
3. How did you find the session with <u>Little</u>	64.7% of participants found it informative.

Questions	Responses
Scientists [a government program focused on early childhood experiences and STEM]?	
4. How would you describe the session with some social science /humanities experts from the university?	47.1% of participants said they would use the ideas presented with their own students.
5. Would you like to hear from other STEM and HPC teachers, for example, YY from ZZ Public School?	70.6% said this session was either excellent or very useful. Frequent comments included “surprise at how behaviour changes when [STEM] learning is motivating and engaging”, usefulness of “quality picture books/literature in effective STEM”, the need to “keep the focus short, i.e., smaller more doable projects”, “being willing to trial n’ error” and how STEM “re-energised” a personal sense of “professionalism and practice.”
6. How would you describe the STEMShare workshop?	70.6% said this session was either excellent or very useful.
7. Final reflections.	Comments were very positive about the day; dominated by attention to how hearing from other teachers “was powerful”; “wanting more time to talk with teams from other schools”; “noting our growth in confidence”; “the Google+ community was useful to keep everyone connected”, “it was a chance to understand what it means to teach in a sequence of learning”, and “to boost tech skills even more”.

Conclusion and Discussion

Results of the SD evaluations confirm how ML are able to learn from one another and from outside experts and then bring this experience to their work with coaches or mentees in classrooms. As is evident in Tables 2 and 3, learning with STEM experts and rehearsing hands-on activities like coding, using green screens, and making robotics kits were memorable activities. Significantly, professional readings and sharing in team meetings at school, the development of a shared language to talk about planning, and access to an online Google + community with colleagues and visits to ‘buddy’ schools are important. Contextualized PD highlights the importance of deepening collegial relationships and trust so that

ML can take risks with new and different teaching practices, especially when integrating content from several discipline areas (Day & Grice, 2019).

Teams at the six schools in this study plan to continue their work in STEM. As one ML said, “The research acted as a disruptor to many teachers’ pedagogy and their perceptions of content knowledge in four and often five disciplines when it became STEAM.” The value of a pedagogical approach to STEM using the HPC framework for technology-enhanced learning is strongly supported by the study’s findings[5]. Teachers leading in the middle clearly want to work together in teams to solve the problems of practice, but they must be supported to audit existing content heavy units of work/programs and be given time to think and plan together in their stage teams and with ‘buddy’ schools’’ if they are to continue to inspire the next generation of children to take their ‘STEM steps’ towards secondary schooling. Innovations often fail when educators “only focus on the surface features of the innovation rather than the underlying mechanism[s] that enable it to work” (Lewis, Perry, & Murata, 2006, p. 5).

A core part of this bespoke PD in the two SD was an academic partnership with the ML that focused on transforming their agency in STEM practice through self-reflective enquiry in action research cycles. When given the chance, through PD funded in a sustained experience over 15 months, these ML became highly enthusiastic about co-teaching large student groups and coaching and leading their colleagues. They were deeply committed to reflecting on their own learning and to refining and growing their teaching practices in STEM to be agents of change.

Notes

1. PISA is the Program for International Student Assessment in reading, mathematical and scientific literacy, and TIMSS is the Trends in International Mathematics and Science Study; both are international standardized tests that are the subject of considerable political controversy and debate in many countries. In Australia, primary schools cater for students aged 5 to 12 years of age.
2. Inquiry in this paper draws on Murdoch’s (2015) ideas that teachers and children are at their “learning best [when] engaged in the powerful act of inquiry – be it challenging, playful, individual, collaborative, closely guided or independent” (p. 13).
3. The university ethics committee and the state education regulator approved the research; it was conducted in 2017–2019 (Approval No. ETH17-1467 and SERAP No. 2016182).
4. The main study limitations concern sustainability of what was found over time and understanding how leading from the middle impacts practice in the context of PD and a pedagogical approach to STEM education in the long term.

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IMPLEMENTING TABLETS IN NORWEGIAN PRIMARY SCHOOLS: EXAMINING OUTCOME MEASURES IN THE SECOND COHORT

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Abstract

This study examines the implementation of tablets in primary schools in Norway. The outcome measures in the study are external for the intervention and are recorded data from national tests (National reading, arithmetic and English Tests, Classes 5, 8 and 9; National Mapping Tests for reading and arithmetic, Classes 1–3; and the 2014–2017 National Pupil Survey). The entire study (N=15, 708) relies on an explanatory, sequential mixed-methods design (Fetters, Curry, & Creswell 2013), and in this study we examine the quantitative effects of this implementation. The results indicate that the impact of tablets on pupils' school achievement varies. It seems that tablets contribute more positively to boys' school achievements than to girls' school achievements. However, we cannot rule out that a grade effect may also have an impact on the results, and we therefore request that the results be read with this reservation.

Keywords: tablets, digital schooling, implementation, primary school, Norway

1. Introduction

This article examines the second cohort of the trailing research in the Municipality of Bærum's (2015) *Everyday Digital Schooling* tablet project, which examines outcome measures regularly through our longitudinal research design. The first study examined the first nine months of this project (Krumsvik, Berrum, and Jones, 2018). This second study examines the next 24 months of the project period. These two first studies are the first large-scale effect studies of the implementation of tablets in Norwegian primary schools where the outcome measures are external for the intervention, as recommended by, for example, Cheung and Slavin (2013). This means that the learning outcome in this study is the combined result of national tests, the National Mapping Tests and the National Pupil Survey (administered by The Norwegian Directorate of Education and Training).

The aim of introducing tablets as a primary learning aid for all pupils at all stages at the pilot schools was to improve the academic and personal outcomes acquired by the pupils from their schooling. Investing in tablets had two objectives: to challenge teachers to develop and change their own teaching and working practices wherever possible, and to help with the provision of better learning for pupils. However, to avoid Cheung and Slavin's (2013) critique concerning educational technology studies using measures designed by the researchers themselves, we applied external outcome measures (registry data). In this part of the trailing research, the outcome measures in the study are external for the intervention and are recorded data from National Tests (National reading, arithmetic and English tests, Classes 5, 8 and 9, National Mapping Tests for reading and arithmetic, Classes 1–3, and the 2014–2016 National Pupil Survey) in a municipality in Norway. In this second cohort of the trailing research, we only examine the quantitative effects of this part of the implementation. The paper first presents a conceptual framework and the methodology of the study, followed by the results and a discussion of the study's main findings.

2. Conceptual framework

2.1. Literature Review

Norwegian schools are implementing tablets in schools to an increasing degree, and there seems to be a need for more research within this area to examine how this implementation affects pupils' learning processes (OECD 2008; Krumsvik, Egelandsdal, Sarastuen, Jones, & Eikeland, 2013). There are a limited number of large-scale research studies within the application of this kind of tablet technology for educational purposes. More research is therefore needed within this area, especially since we know that throughout the world there are initiatives at various policy levels regarding the implementation of tablets in schools.

Norway has had a high technology density both in homes and in schools during the last 10 years, and it is therefore interesting to examine how tablets affect school achievement variables. This is also related to the present national curriculum (Kunnskapsdepartementet, 2006) and the upcoming national curriculum (The Ministry of Education 2017; The Norwegian Directorate of Education and Training, 2018a), which both highlight digital skills and digital competence among pupils in school.

A recent doctoral thesis from Norway by Kongsgården (Kongsgården, 2019; Kongsgården & Krumsvik, 2016; Kongsgården & Krumsvik, 2019), shows that the implementation of tablets in schools is a complex process with both new educational possibilities and pitfalls. The study shows that tablets play a certain role in the learning process, especially in the achievement of learning goals and access to the Internet. However, there are clear differences in how pupils use tablets in their learning processes. In particular, there is a difference between primary and secondary school. Kongsgården's study (Kongsgården, 2019) also indicates that a teaching design that includes educational technology contributes to an increase in learning outcomes. Through the teacher's didactical choice, there is evidence that the teacher, by creating a learning community focusing on assessment for learning and technology, establishes flexible and transparent learning processes that develop the pupils' self-regulation. The study shows that the critical success factor is the teacher and his or her ability to create a teaching plan where the use of technology is justified by didactic choices and not vice versa (Kongsgården, 2019; Kongsgården & Krumsvik, 2016; Kongsgården & Krumsvik, 2019).

Another PhD study from Norway examines the effect of adaptive learning technologies (ALT) and the use of tablets (Moltudal, Høydal, & Krumsvik, 2019) in grades five to seven (10-12 years of age) in mathematics. The findings of the study indicate that the use of ALT at the upper primary level contributed positively to basic pupil learning in mathematics (ES = 0.39, P = 0.001). However, the study also indicates an intertwined relationship among learning, motivation, and volume training, especially for pupils learning new mathematical concepts. However, successful implementation requires that teachers have expertise in classroom management. It also shows that one of the main educational challenges lies in changing teachers' traditional practice by implementing a digital didactic method that provides the teacher with a greater understanding of digital homework as a measure *for*, and opportunity to better understand where pupils are *during*, the learning process.
Tamim, Borokhovski, Pickup, Bernard & El Saadi (2015a) carried out a systematic review of current government-supported tablet initiatives around the world, in order to understand more of the educational basis and underlying principles in general. This review concluded "that the majority of these initiatives have been driven by the tablet hype rather than by educational frameworks or research-based evidence" (p. 9).

To a certain degree, Escueta, Quan, Joshua, and Oreopoulos (2017) find some of the same tendencies in their evidence-based review of educational technology in general. They find that it is not enough to provide students with access to technology – it has to be based on a reflective pedagogical teaching design.

Fairlie and Robinson (2013) revealed much of the same when they examined the effects of home computers on academic achievement among schoolchildren. They concluded that "we find no evidence that home computers had an effect (either positive or negative) on any educational outcome, including grades, standardized test scores, or a host of other outcomes" (p. 234). From these three studies (and also from earlier meta-analysis as e.g., Tamim, Bernard, Borokhovski, Abrami & Schmid (2011), we can see that *access* to technology is not enough – it seems to be a consensus in the research community that technology has to be closely attached to well-founded pedagogy and didactics. So, what do we know from recently published meta-analyses about tablets and mobile technology in pedagogical settings?

A meta-analysis by Sung, Chang, & Liu (2016) finds that "the overall mean effect size for learning achievement…was 0.523, meaning that learning with mobiles is significantly more effective than traditional teaching methods that only use pen-and-paper [*sic*] or desktop computers" (p. 257). For tablet PCs, they find a specific effect size of 0.615. Sung et al. (2016) also state that if we compare these effect sizes with Kulik and Kulik's (1991) and Tamim et al.'s (2011) meta-analyses of the difference between using computers and not using computers in education (effect size between 0.30–0.35), some of the reason for these improved effects might be attached to the affordances that specific tablet and mobile technology give. However, Sung et al. (2016) emphasise that more research is needed to examine such issues.

Tamim, Borokhovski, Pickup, Bernard & El Saadi (2015b) carried out a meta-analysis of 68 studies based on 27 quantitative studies and 41 qualitative research studies, and concluded that "findings from the current meta-analysis indicate a moderate strength average effect size for the impact of tablets and smart mobile devices on student outcome measures" (p. 38).

These two meta-analyses are up to date, give some promising results, and indicate that tablets represent a type of hardware with affordances other than those of traditional computers. However, these are preliminary tendencies, and we need more research into the affordances tablets might or might not give. Concerning literacy more specifically, Genlott and Grönlund (2016) examined the effects of the "Write to Learn" (WTL) method. The results showed that the WTL group achieved the best results, and they concluded that access to technology is not enough; information communication technologies (ICT) have to be included in both didactical and pedagogical elements in instruction.

In their meta-analysis of the effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms, Cheung and Slavin (2013) find only a positive, modest effect of d=0.15. In another meta-analysis examining how features of educational technology applications affect student reading outcomes, they also find positive, modest effects of d=0.16 (Cheung & Slavin, 2012). They explain that high quality studies (included in their meta-analysis) within educational technology give a lower effect size than do studies with methodological weaknesses (excluded from their meta-analysis).

On the basis of this literature review, we find that despite the existence of some international research concerning tablets (and other types of educational hardware) in schools, we have very little research knowledge about how the large-scale implementation of tablets affects pupils' learning outcomes in Norway. Our trailing research is therefore positioned towards this gap, and will provide empirical data as related to our research questions.

2.2. Theoretical Framework

Certain theoretical discussion is related to whether it is the educational technology (e.g. tablets) by itself that affect learning or whether it is the teaching method, teacher and other factors. Such debates have been going on since the 1980's and are still debated in today's research communities. However, Cheung and Slavin (2013) provide a certain "middle way out" solution:

> Though it may be theoretically interesting to ask whether the impact of technology itself can be separated from the impact of particular applications, in practice, technology, content, and method are often intertwined and cannot be separated. As is the case for many

> educational interventions with many components, currently available technology applications can be seen as packages of diverse elements and evaluated as such. If a particular combination of hardware, software, print materials, professional development for teachers, and other elements can be reliably replicated in many classrooms, then it is worth evaluating as a potential means of enhancing student outcomes. Components of effective multi-element treatments can be varied to find out which elements contribute to effectiveness and to advance theory, but it is also of value for practice and policy to know the overall impact for students even if the theoretical mechanisms are not yet fully understood. (p. 92)

Thus, this paper has no ambitions to develop new theory, but to apply theory as Leedy and Ormrod (2005, p. 4) describe it: "A theory is an organized body of concepts and principles intended to explain a particular phenomenon". The theoretical framework for the entire study underpins the research questions (and are not an analytical framework). The theoretical framework refers to the theories of Piaget (1967) and Vygotsky (1978), where tablets are related to both knowledge construction and collaborative learning, and linked to student-centred and group-based teaching design. Educational technology (like tablets), as it appears today in Bærum schools with its distinctive feature of digital tools, relates especially to more recent socio-cultural perspectives on learning (Wertsch, 1998; Cole, 1996; Säljö, 2005, 2017; Stahl, 1993; Lave & Wenger, 1991; Wenger, 1998) as a mediating artefact. The socio-cultural perspective emphasises the point that learning is constructed in interaction with other people and mediating artefacts, which has a significant focus on the basic thinking in the "Digital everyday school" school development project. James Wertsch states that such new kinds of mediation and mediated artefacts can give new possibilities and the experience of "…how the introduction of novel cultural tools transforms the action" (Wertsch, 1998, p. 42). The use of tablets for learning purposes also relates to Richard Mayer's (2010) *Multimedia Learning Theory* where he describes learning *with* technology, such as situations wherein technology is used for the purpose of promoting learning, and is concerned with the human *construction of knowledge* as a framework for learning.

However, tablets are a type of hardware that can be applied in numerous ways, and it is important to understand the affordances of such technology and the context of use. This is based on the fact that there are several similarities between ICT for entertainment use and educational technology for use in school, and sometimes it is hard to distinguish the two. However, educational technology is developed especially for educational purposes, while ICT consists of a myriad of technologies such as social media, mobile phones, wireless broadband, PCs, and so on, which are developed first and foremost for everyday life (and not specifically for educational purposes). Tablets can be used in both contexts, but in this study we examine tablets as an educational technology with certain affordances for teaching and learning in school contexts. Cheung and Slavin (2013) state that educational technology has a variety of definitions in the literature; in this paper educational technology refers to the use of tablets in school settings for educational purposes to support learning process and learning goals. Thus, our theoretical underpinning for the study is also attached to *digital didactics*. This concept was introduced by Krumsvik (2008) and was further examined in subsequent studies (Krumsvik, 2009a; Krumsvik, 2009b; Almås & Krumsvik, 2008; Krumsvik, 2012). Similar to the later digital didactic models of, for example, Jahnke, Bergström, Mårell-Olsson, Häll, and Kumar (2017), this digital didactic model focuses on the most relevant elements teachers need to consider in the digitalised school with the awareness that "… adding 21st-century technologies to 20th-century teaching practices will just dilute the effectiveness of teaching" (Organisation for Economic Co-operation and Development [OECD, 2015, p. 5).

Another element to consider (which has both theoretical and methodological implications) is that:

> Many evaluations of technology applications suffer from serious methodological problems. Common problems include a lack of a control group, limited evidence of initial equivalence between the treatment and control group, large pretest differences, or *questionable outcome measures*. In addition, many of these reviews included studies that had a very short duration. Unfortunately, studies with poor methodologies tend to report much higher effect sizes than those with more rigorous methods (…), so failing to screen out such studies inflates the average effect sizes of meta-analyses. (Cheung & Slavin, 2013, p. 92, our italics)

On this basis, the outcome measures in this study lies outside the intervention (registry data). The coherence among pupils' knowledge construction and collaborative learning linked to student-centred teaching design in schools (attached to sociocultural theory), learning with technology (tablets) attached to multimedia learning theory, and teachers' pedagogical practices (in relation to digital didactic) underpins the research questions of the study, which in the first cohort were:

1. To what extent does the implementation of tablets affect learning outcomes in schools in Bærum Municipality (where the outcome measures are recorded data such as National Mapping Tests, National Tests and the National Pupil Survey)?
2. To what extent does the implementation of tablets affect social enjoyment and learning environments in schools in Bærum Municipality (based on the National Pupil Survey)?

To be able to examine these same variance research questions in the second cohort, we have chosen trailing research and mixed method research, described below.

3. Methodology

The research design made use of trailing research (Finne, Levin, & Nilssen, 1995) and mixed method research (Fetters et al., 2013), which involved combining different methods and data sources. To be able to answer the research questions in this study, we have chosen to design this study as an explanatory, sequential mixed-methods design (Fetters et al., 2013). We follow the *staged approach*, which means that data are reported in stages and published separately. In this article (the second cohort), we therefore only report the quantitative effect analysis which is based on existing recorded data. The effects of the learning results are measured by using the following data sources:

1. National reading, arithmetic and English tests, classes 5, 8 and 9 from 2014-2017.
2. National Mapping Tests for reading and arithmetic, classes 1–3 from 2015-2017.
3. The 2014–2017 National Pupil Survey.

We have obtained the results of the National Tests from the Norwegian Directorate for Education and Training's school portal, and the results of the National Mapping Tests have been provided by the Municipality of Bærum. Our two endpoints in this respect are based on class levels, divided according to gender and test type. Data from the national arithmetic and English tests have been taken from 2014 to 2016, since there is no comparable data available prior to 2014. The reading test is nevertheless included in our analysis, but with the reservation that changes have been made to the scale, so that the comparison cannot be made beyond 2016. However, this should not be a problem since the comparison is only made up to 2016. As regards the Mapping Tests, two respective tests were conducted in reading and arithmetic between 2014 and 2016.

Our third and final endpoint is social enjoyment and learning environments. This has been gathered from the National Pupil Survey. The National Pupil Survey focuses on how pupils perceive their learning environment at school, how motivated they are, their social well-being at school, if they experienced any bullying, how they experience the teachers, and so on. The results of the National Pupil Survey have also been obtained from the Norwegian Directorate of Education and Training's[1] school portal, based on class levels and divided by gender. Our basis includes the various indicators defined by the Directorate as being relevant for pupils' learning environments. We used data from the National Pupil Survey covering 2013 to 2015. No data for 2016 was available in the school portal when our analysis was carried out.

4. Quantitative Results

This section presents the quantitative surveys that have been made and the findings that emerge from these. We will present the analyses of our effect analyses, which are based on the last available registry data. Here we investigate the effect of the introduction of tablets on pupils' learning outcomes (in basic skills) and learning environments. The three effect measures analysed are the results of the National Tests in the fifth and ninth grades, the National Mapping Tests first to third grade, and the results from

[1] More information here: https://skoleporten.udir.no/

the National student survey (The Norwegian Directorate of Education and Training, 2018) in the seventh and tenth grades.

4.1. Effect Analyses

The purpose of the effect analyses is to investigate the effect of introducing tablets into pupils' learning exchange and learning environment. Then, pupils' learning outcomes and learning environment are compared with schools where tablets have not yet been introduced for all pupils.

The impact on learning outcomes is measured using the following data sources:

1. National tests in reading, mathematics, and English in the fifth, eighth and ninth grades.
2. National Mapping Test in reading and mathematics in first through third grade.

The results from the National tests are taken from the website of the Norwegian Directorate of Education and Training's (2018), "Skoleporten", as well as from the results of the national survey tests which we received from Bærum Municipality. Our two effect measures here are based on grade level, divided by gender and type of test. For the mapping tests, two tests are carried out in reading and mathematics, respectively.

The impact on pupils' learning environment is measured using collected data from the National Student Survey (The Norwegian Directorate of Education and Training, 2018) in seventh and tenth grades, based on grade and divided by gender. Furthermore, we use the different indicators that the Directorate of Education has defined as relevant to pupils' learning environment.

All three effect targets are linked with data at the school level from the "Primary School Information System" (GSI) in addition to socioeconomic indicators for the 24 children's schools in Bærum municipality.

4.1.1. Description of the Sample as the Basis for Effect Analyses

Table 1 below describes the pupils in Pilot 1 and Pilot 2 schools, as well as the pupils at other schools, where we investigate whether or not there are differences between schools that have used tablets and schools that have not.

Table 1
Description of the Pilot Schools and Non-pilot Schools

	Pilot 1	Pilot 2	Non-pilot schools
Number of schools (total)	5	10	29[a]
Number of pupils (total)	1,743	4,395	9,570
Percentage of secondary schools	40 %	30 %	31 %
Percentage of schools above 400 pupils	20 %	60 %	34 %
Average number of pupils per year[b]	15.3	16.4	13.4
Average number of assistant hours per pupil	10	8	23
Sociodemographic variables:[c]			
Percentage with low income (b. 50% median)	7.7 %	7.1 %	7.4 %
Percentage with low or no education	18.5 %	16.3 %	17.2 %
Percentage of social help recipients	2.0 %	1.1 %	1.6 %
Percentage with immigrant background	18.0 %	13.5 %	16.2 %

Note: There are no significant differences between group schools and other schools. The significance is tested by a two-tailed independent T-test with equal variance of 10 %, 5 %, and 1 % significance level.

[a]The 10 group schools from group 2 were taken out of the control group when they introduced tablets in August 2016 and therefore cannot act as a control group for an after-survey survey in 2017. [b]There is a significant difference between group 2 schools and other schools in the variable average number of students per year at a 10 % significance level. There are otherwise no significant differences between group schools and other schools on the other variables. [c]Source: Indicators from 2011 in nine areas in Bærum calculated by Statistics Norway. The distribution between the schools is made by the Municipality of Bærum. For some schools, a percentage distribution has been developed between several areas.

Findings

Pilot 1 schools do not differ significantly from other schools in Bærum.
In the socioeconomic parameters, there are also no statistically significant differences between Group 1 schools and other schools. As described in the previous report, one should be careful when drawing conclusions based on the socioeconomic variables, as they are from 2011. At the same time, the pupil base in the surrounding area is expected to be relatively constant as the school district changes only marginally each year. In the analysis, the indicators are used only to test the robustness of the results in comparative analyses, and not as an independent analysis.

Group 2 schools differ from other schools by having a slightly lower proportion of secondary schools, larger schools, more students per year, and fewer assistant hours per student. However, these differences are on the whole not significant.

In the socioeconomic parameters, we see that Group 2 schools are in an area with a lower proportion of children with immigrant background than are the other schools (the opposite of what we see for Group 1 schools). However, there are no statistically significant differences between the school groups in any of the socioeconomic parameters.

The parameter showing the greatest variation between the three school groups is "Number of students per year". Here, the other schools have the lowest average. This could potentially contribute to better student outcomes for these students. However, we have taken this into account through our difference-in-difference analytical approach (see 4.1.2).

4.1.2. On Method and Identification of Effect

The effect analysis is performed with a difference-in-difference approach in a simple average analysis and a more advanced fixed-effect regression analysis. In a simple "diff-in-diff" analysis, the average difference between the five Pilot schools and all other schools in Bærum is considered before the introduction of tablets. This is compared with the difference between group schools and all the other schools in Bærum after the introduction of tablets. Figure 1 below illustrates the difference-in-difference approach in our study.

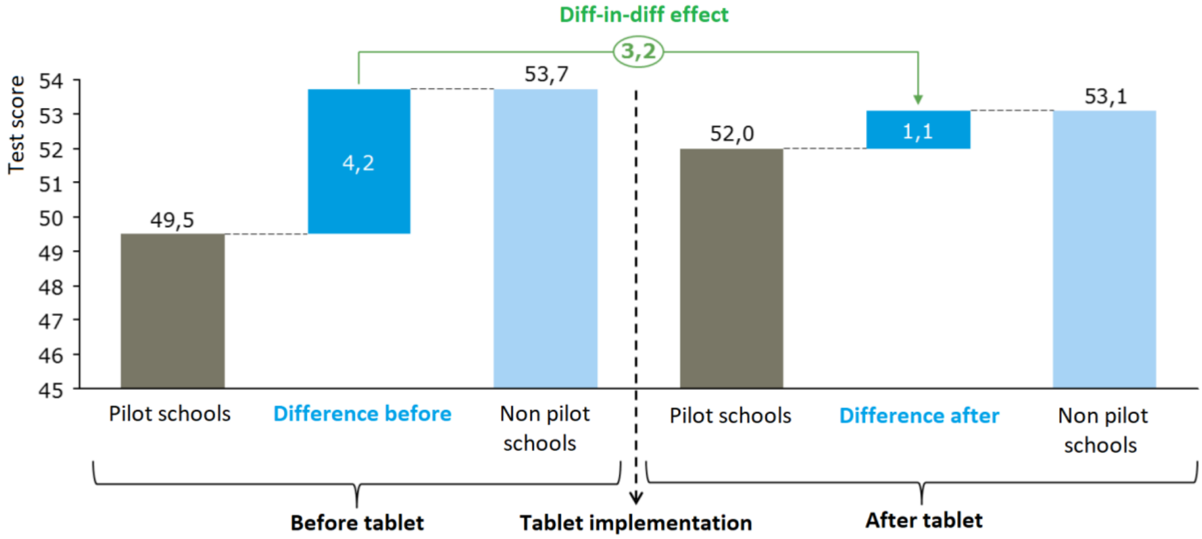

Figure 1. Illustration of the difference-in-difference approach. The green bubble is the estimated effect of the introduction of tablets.

Using a diff-in-diff approach in a more advanced fixed-effect regression analysis, as you can check for time constant variables at the school level. This means variables that do not change over the years - such as school size, geographical location, and organisation - will be checked for. In addition, the method takes into account unobservable characteristics that are constant over the years, such as school culture, student basis (assuming student base is not changing), and the like.

4.1.3. Reservations and Uncertainty in the Analysis

In diff-in-diff analyses (both simple and fixed-effect analysis), it is assumed that schools would have developed equally if the pilot schools had not introduced tablets. This assumption is necessary, as in a diff-in diff analysis the pilot of schools without intervention defines the counterfactual situation of schools that have introduced tablets. That is, after taking into account the different starting points of the school before the introduction of tablets, they are expected to have the same development over the years in the national tests, national mapping tests, and the National Student Survey. This is a strict assumption, and it cannot be tested in the data we have available. Therefore, in the interpretation of the results, it should be noted that there may be cases where Group 1 schools without the introduction of tablets could still have developed as they did. One way to approach this strict assumption is to include variables that describe pupils' individual backgrounds. As we have not had access to such data, we have also not had the opportunity to take this information into account in the analysis.

In addition to the strict assumption of development, another uncertainty occurs in the form of a "grade effect". By grade effect, it is believed that the analysis is based on the comparison of students in a single grade, for example, in fifth grade, with the subsequent graduation of students in fifth grade. In other words, the same students are not followed. This implies that there may potentially be students who overall are better or worse, contributing to a proven effect of tablets, and not the characteristics of the tablets themselves. The grade effect can be tested by following a student group over two grades (for example from first to second grade), thus evaluating whether the tablet changes the results in the same student group.

This also means that the results cannot be generalised to other schools or municipalities. Furthermore, we have an analysis of measurable effects, which means that the analysis does not capture potential effects on learning beyond the measurable indicators. All results must therefore be seen in the light of these reservations.

4.1.4. Identification of Effects

The chart below (Figure 2) shows an overview of when the group schools introduced tablets. The overview also shows when the various impact targets were collected at a national level. Furthermore, the grey areas mark the years used as before and after measurements.

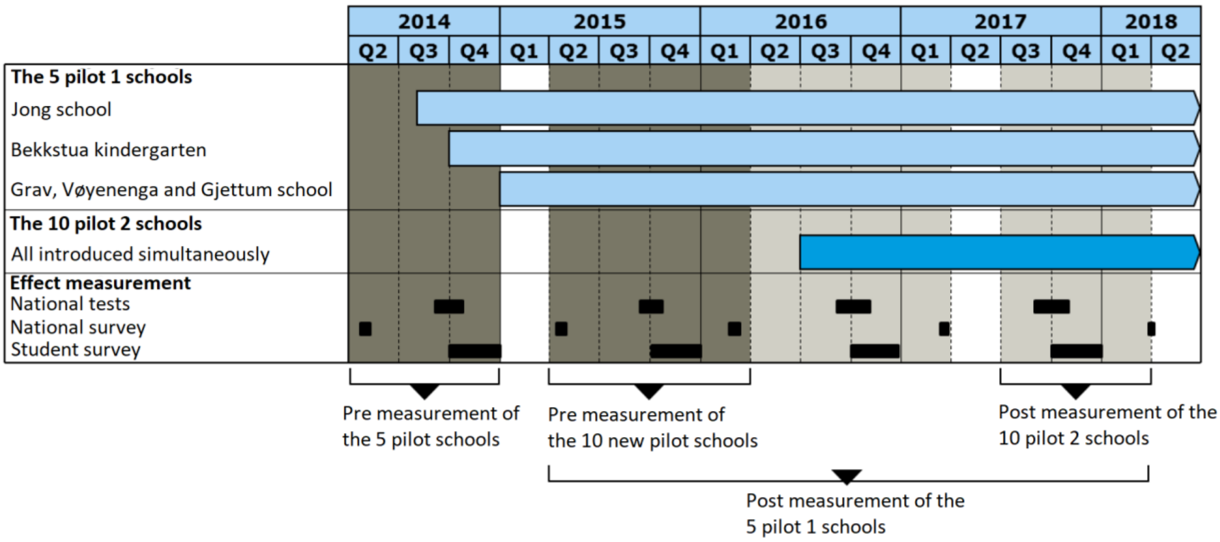

Figure 2. Overview of the introduction of tablets and the three effect measurements.

The effect measurements from 2014 and 2015 are used as preliminary measurements for Group 1 and Group 2 schools, respectively. However, it must be noted that the pre-measurement of the National Student Survey and the National Tests for Jong school and Bekkestua primary school may be influenced by the fact that the schools in question introduced tablets already in autumn 2014. However, state surveys in 2014 and 2015 qualify as preliminary measurements for all schools, as they were collected in the spring of the same year.

The reason 2013 data is not used in the National Tests for Group 1 schools is that the National Tests in 2013 are not comparable with data from 2014 and later. For the student survey, however, 2013 can be used as a measure for Group 1 schools. Nevertheless, the measurements from 2014 are used to see the three analyses in one. As a reassessment, data are used from 2015, 2016, and 2017.

4.1.5. Results from National Tests in Primary School

Results will be divided so that the results of the national samples are described first. Then the results of the surveying tests are presented, and finally the results from the student survey. In conclusion, a brief summary of the results follows.

Effects for Group 1 in Fifth Grade (Analysis 1)

Table 2 shows the average test results for national tests in reading, arithmetic and English for all children, boys and girls. A positive number in the Effect column on the right indicates that Group 1 schools have developed favourably compared to other schools in Bærum after the introduction of tablets. The analysis was completed in 2017, i.e., it reports on the effect for 2017. In addition, the results of the previous report are included in the first column in order to compare short-term and longer-term effects.

Table 2

Difference-in-difference Analysis of Fifth Grade Test Results (Pilot 1 Schools)

		Effect (2015,2016)	Before tablet (2014)		After tablet (2017)		Effect (2017)
		Diff-in-diff	Pilot schools	Non-pilot schools	Pilot schools	Non-pilot schools	**Diff-in-diff**
All	Reading	3,4	-	-	-	-	-
	Arithmetics	3,2	49,5	53,3	51,5	51,3	4,0
	English	3,7	50,5	53,0	55,0	51,5	6,0**
Boys	Reading	4,3	-	-	-	-	-
	Arithmetics	5,9*	49,5	54,8	52,5	52,6	5,1
	English	4,7*	49,5	53,7	56,0	52,3	7,9***
Girls	Reading	1,7	-	-	-	-	-
	Arithmetics	0,3	49,5	52,1	49,5	50,8	1,4
	English	3,1	51,0	53,1	53,5	51,3	4,3
Number of schools [a)]			**2 Schools**	**16 Schools**	**2 Schools**	**16 Schools**	

Note: The significance is tested by a two-tailed independent T-test with equal variance of 10 %, 5 %, and 1 % significance level. If a number does not include asterisks, there is no statistical difference.

[a] Bekkestua Primary School is not included in the analysis, as at the time of measurement it did not have its own fifth grade.

*with 90% certainty there is a difference between the effort group and the control group. **with 95 % certainty there is a difference between the effort group and the control group. ***with 99 % certainty there is a difference between the effort group and the control group.

National tests in reading cannot be compared after 2016, as changes have been made to the scale of this test. Therefore, the result for reading is omitted from the analysis, as all the measurement for reading takes place after 2017.

In general, the impact of tablets has increased since the measurements collected in 2015 and 2016.

The effect of introducing tablets is significantly positive for *boys* in fifth grade in English (as in 2015/2016). Furthermore, the effect is also positive and significant for *all children* in fifth grade in English, when the effect is measured in 2017. For *girls*, we cannot say with statistical certainty that a change has occurred. If a change is to be found in the latter group, the results indicate that the change is likely to be positive.

The fifth-grade boys also had a significant positive effect in the use of tablets in mathematics measured in 2015/2016. This effect is no longer significant in 2017.

We also conducted a similar analysis for the three levels of mastery in arithmetic, reading, and English (data is available upon request). In general, the proportion of students in third grade in English rises significantly more for pilot schools than other schools after the introduction of tablets. It also results in a significant negative effect in Level 2 (albeit trend of positive performance), as a large proportion of Level 2 students pass to Level 3.

Effects for Group 2 in Fifth Grade (Analysis 1)

Table 3 shows the average test results for national tests in mathematics, reading, and English for all children, boys and girls. A positive figure in the Effect column on the right indicates that Pilot 2 schools have developed more positively than the other schools in Bærum after the introduction of tablets. Both 2016 and 2017 are included in the aftermath, which means that the measured effect is an average of the effects in 2016 and 2017.

Table 3

Difference-in-difference Analysis of Fifth Grade Test Results (Pilot 2 Schools)

		Before tablet (2014,2015)		After tablet (2016,2017)		Effect
	Basic skill	**Pilot schools**	**Non-pilot schools**	**Pilot schools**	**Non-pilot schools**	**Diff-in-diff**
All pupils	Reading [a)]	53,5	53,2	53,4	52,1	1,0
	Arithmetic	54,4	53,1	53,3	51,9	0,1
	English	53,0	53,0	52,9	51,9	1,0
Boys	Reading [a)]	52,3	53,3	53,3	51,7	2,5
	Arithmetic	55,4	54,3	54,2	52,9	0,2
	English	53,8	53,5	53,5	53,0	0,2
Girls	Reading [a)]	53,7	53,7	53,4	52,3	1,1
	Arithmetic	53,3	51,9	52,1	51,3	-0,7
	English	52,4	52,8	52,0	51,2	1,3
Number of schools		**7 schools**	**16 schools**	**7 schools**	**16 schools**	

Note: The significance is tested by a two-tailed independent T-test with equal variance of 10 %, 5 %, and 1 % significance level. If a number does not include asterisks, there is no statistical difference.

[a]National tests in reading cannot be compared beyond 2016, as changes have been made to the scale of this test. The sample is therefore not included in this type of sample in 2017.

*with 90 % certainty there is a difference between the effort group and the control group. **with 95 % certainty there is a difference between the effort group and the control group. ***with 99 % certainty there is a difference between the effort group and the control group.

It is considered that national tests in reading cannot be compared to 2016, since the reading for the reading exam consists only of 2016. This is also described in the note below the table.

There are no statistically significant effects to be found for pilot 2 schools as compared to other schools measured in terms of the national fifth-grade tests. This corresponds to the fact that we did not find any effect for pilot 1 schools at this time (i.e. after a relatively short period of time).

Effects for Group 2 in Fifth Grade (Analysis 2)

The fixed effect analysis in Table 4 (group 2) reinforces the results in the difference-in-difference analysis from Table 3 (group 2), where we do not find positive significant effects for all students or any of the two gender groups. At the same time, note that the effect in reading for boys in the fifth grade is significantly positive, albeit as a short-term effect, as the effect of introducing tablets on reading skills is only measured in 2016 (see point below). This means that in 2017 we cannot say with statistical certainty that there has been a positive change in the development of students' reading skills.

Table 4
Difference-in-difference in Fixed Effect Regression Analysis in Fifth Grade (Pilot 1 schools)

	All pupils		Boys		Girls	
	Arithmetic	English	Arithmetic	English	Arithmetic	English
Group school	0	6,3	-2,7	1	4	-8,7
After implementation	-2,1***	-3,2***	-2,2**	-1,5*	-2,1**	-2,3*
Effect of tablet (2017) [a)]	4,3**	3,2*	5,7	9,1***	3	2
Large schools [b)]	-0,7	8,1***	-1,2	-2,3	-2,7	5,1
Number of pupils per year	-0,4	-1,5***	-0,3	-0,3	-1,1**	-0,7
FE, School level	Ja	Ja	Ja	Ja	Ja	Ja
Explanatory power (R^2)	0,93	0,88	0,84	0,81	0,89	0,66
Number of obs.	36		36		37	

Note: The significance is tested by a two-tailed independent T-test with equal variance of 10 %, 5 %, and 1 % significance level. If a number does not include asterisks, there is no statistical difference.

[a]The effect of tablets is an interaction between a dummy variable to be the intervention school and dummy variable to be after the implementation. I.e. the effect is calculated by a difference-in-difference approach. [b]A big school is defined as a school with 400 students or more.

*with 90 % certainty there is a difference between the effort group and the control group. **with 95 % certainty there is a difference between the effort group and the control group. ***with 99 % certainty there is a difference between the effort group and the control group.

The national test in reading cannot be compared to 2016, since the reading for the reading exam consists only of 2016. It is also described in the note below the table. For the other national tests (Arithmetic and English), both 2016 and 2017 have been included in the survey.

The fixed effect analysis has taken into account time-constant characteristics at school level, as well as school size and number of students per year.

4.1.6. Results from National Tests at Secondary School

Table 5 shows the average test results for national tests in arithmetic and reading for all children, boys and girls, in ninth grade for Pilot 1 schools and other schools.

Table 5

Difference-in-difference Analysis of Average Test Results, Ninth Grade (Group 1)

		Effect (2015,2016)	Before tablet (2014)		After tablet (2017)		Effect (2017)
		Diff-in-diff	Pilot schools	Non pilot schools	Pilot schools	Non pilot schools	Diff-in-diff
All	Reading[a)]	-1,7	-	-	-	-	-
	Arithmetic	-2,1	57,5	57,1	56,0	57,6	-1,9
Boys	Reading[a)]	0,2	-	-	-	-	-
	Arithmetic	-1,9	58,0	57,9	58,0	58,9	-1,0
Girls	Reading[a)]	-3,0	-	-	-	-	-
	Arithmetic	-2,7	56,5	56,3	54,5	55,9	-1,6
Number of schools			**2 schools**	**7 schools**	**2 schools**	**7 schools**	

Note: The significance is tested by a two-tailed independent T-test with equal variance of 10 %, 5 %, and 1 % significance level. If a number does not include asterisks, there is no statistical difference.

[a]The test in reading cannot be compared to 2016 and therefore 2017 is not included in the survey.

Effects for Group 1 in Ninth Grade (Analysis 1)

A positive number in the Effect column on the right would indicate that Pilot 1 schools have developed more positively compared to other schools in Bærum after the introduction of tablets in 2017; however, the numbers are negative. The analysis was carried out through a survey in 2017. Furthermore, the result of the previous report (Krumsvik, Berrum & Jones, 2018) is included in the first grey column to compare the short-term effect (2015, 2016) against more long-term effects (2017).

The analysis was completed in the ninth grade, as students in the eighth grade may have attended one of the primary schools that had already introduced tablets, thus creating uncertainty about the results.

National tests in reading cannot be compared to 2016, as changes have been made to the scale of this test (cf. last report, Krumsvik, Berrum & Jones 2018). Therefore, the result for reading is omitted from the analysis, as the measurement takes place in 2017.

None of the results are statistically significant, and therefore we cannot say with certainty that the negative difference is not random. This applies to both the results from 2015/2016 and 2017. However, the same trend with negative results that appeared in 2015/2016 (short term) continued in a slightly longer term time frame. in 2017.

Effects for Group 2 in Ninth Grade (Analysis 1)

Table 6 shows the average test results in the national test in arithmetic and reading for all children, boys and girls, in ninth grade for Pilot 1 schools and other schools. A positive number in the Effect column on the right would suggest that Pilot 2 schools have developed more positively than other schools after the introduction of tablets; however, the numbers are negative. Both 2016 and 2017 are included in the aftermath, which means that the measured effect is an average of the effect in 2016 and 2017.

Table 6

Difference-in-difference Analysis of Average Test Results, Ninth Grade (Group 2)

		Before tablet (2014,2015)		After tablet (2016,2017)		Effect (2016,2017)
		Pilot schools	Non pilot schools	Pilot schools	Non pilot schools	Diff-in-diff
All	Reading[a)]	58,6	56,8	59,3	58,1	-0,6
	Arithmetic	58,7	57,1	58,3	57,6	-0,9
Boys	Reading[a)]	58,0	55,6	58,7	56,7	-0,4
	Arithmetic	59,8	58,0	60,0	58,5	-0,4
Girls	Reading[a)]	59,0	57,9	60,0	60,2	-1,2
	Arithmetic	57,3	56,2	56,7	56,5	-1,0
Number of schools[b)]		**3 schools**	**7 schools**	**3 schools**	**7 schools**	

Note: The significance is tested by a two-tailed independent T-test with equal variance of 10%, 5% and 1% significance level. If a number does not include asterisks, there is no statistical difference.

[a]The test in reading cannot be compared to 2016 and therefore 2017 is not included in the survey. [b]The number of schools is not equal to the number of observations. There are double numbers of observations in both the pre-measurements and the post-measurements, as both measurements extend over two years, i.e. all schools are included twice. The test in reading is, however, an exception, as only 2016 is included in the reassessment.

None of the results are statistically significant and therefore we cannot say with certainty that the difference is not random.

Effects for Group 1 in Ninth Grade (Analysis 2)

The fixed effect analysis in Table 7 shows the same results as the difference-in-difference analysis in Table 6. This can be seen in the variable "Effect of tablet" in Table 7 where the effect is not significant, which in turn means that we cannot conclude with certainty that there is a difference in the development of pilot schools (Group 1) as compared with other schools.

Table 7

Difference-in-difference in Number of Pupils per School Year. Fixed Effect Regression Analysis in Ninth Grade (Group 1)

	All pupils	Boys	Girls
	Arithmetic	Arithmetic	Arithmetic
Group school	1	-1,8	1,1
After implementation	1,4	0,5	-0,3
Effect of tablet[a)]	**-2,7**	**-0,7**	**-2,3**
Big school[b)]	-6,5**	1,7	-1,3
Number of pupils per year	-0,2	0,5	1,3
FE, school level	Ja	Ja	Ja
Explanatory power (R^2)	0,84	0,73	0,43
Number of observations	18	18	19

Note: Significance tests have been conducted with a linear regression analysis with fixed effect at school and year. If a number does not include asterisks, there is no statistical difference.

[a]The effect of tablets is an interaction between a dummy variable to be the input school and dummy variable to be after the implementation of the bet, i.e., the effect is calculated by a difference-in-difference approach. [b]A big school is defined as a school with 400 students or more.

*with 90 % certainty there is a difference between the effort group and the control group. **with 95 % certainty there is a difference between the effort group and the control group. ***with 99 % certainty there is a difference between the effort group and the control group.

However, we find a significant result for the fixed effect analysis, as it turns out that students in a "Big school" with more than 400 students have significantly lower test results in the ninth grade than do students in smaller schools.

The analysis is performed for 2017 and reading is therefore excluded from the analysis, cf. reasoned justifications (Berrum, Paaske Gulbrandsen, Fyhn Elgaard & Krumsvik (2018).

Effects for Group 2 in Ninth Grade (Analysis 2)

The fixed effect analysis in Table 8 shows the same results as the difference-in-difference analysis in Table 6. This can be read from the variable "Effect of tablet" where the effects are not significant and it cannot be concluded that there is a difference in the development of pilot schools (Group 2) as compared with other schools.

Table 8
Diff-in-diff in Fixed Effect Regression Analysis in Ninth Grade (Group 2)

	All pupils		Boys		Girls	
	Aritmetic	Reading c)	Arithmetic	Reading c)	Arithmetic	Reading c)
Group schools	1,6	0	0,4	2	3,0	2,8
After implementation	0,7	1,3**	0,1	1*	-0,1	2*
Effect of tablet a)	**-1,4**	**-0,5**	**-0,2**	**-0,5**	**-1,2**	**-1,0**
Big school b)	1,2	2,9***	2	4**	-1,6	1,3
Number of pupils per year	0,7	-0,4	0,6	0,4	1,4*	0,1
FE, school level	Ja	Ja	Ja	Ja	Ja	Ja
Explanatory power (R^2)	0,57	0,79	0,55	0,90	0,47	0,59
Number of obs.	40	30	38	29	39	28

Note: Significance tests have been conducted with a linear regression analysis with fixed effect at school and year. If a number does not include asterisks, there is no statistical difference.

[a]The effect of tablets is an interaction between a dummy variable to be the input school and dummy variable to be after the implementation of the bet. I.e. The effect is calculated by a difference-in-difference approach. [b]A big school is defined as a school with 400 students or more. [c]The test in reading cannot be compared to 2016 and therefore 2017 is not included in the survey.

*with 90 % certainty there is a difference between the effort group and the control group. **with 95 % certainty there is a difference between the effort group and the control group. ***with 99 % certainty there is a difference between the effort group and the control group.

4.1.7. Results from National Mapping Tests in First to Third Grades

In the national mapping tests, it is examined whether the students are above or below the concern threshold for the expected learning level. An increase in the proportion of students across the critical boundary at pilot schools may indicate that the introduction of tablets has contributed to increased learning from the first to third grades.

Effects for Group 1 in First Through Third Grade

Table 9 shows the proportion of students over the critical limit in the state assessment tests for reading, where we have selected subtests spelling, reading words, and reading comprehension among several subtests, and state assessment tests on behalf of Pilot 1 schools and other schools in Bærum. A positive value in the column "diff-in-diff" indicates a positive effect of introducing tablets.

Table 9

Difference-in-difference Analysis of Share of Students above Critical Limit: First, Second, and Third Grades (Group 1)

		Before tablet (2014)		After tablet (2017)		Effect (2017)	Effect (2015,2016)
		Pilot Schools	Non-pilot schools	Pilot schools	Non-pilot schools	**Diff-in-diff**	**Diff-in-diff** [b)]
1st grade	Spelling [c)]	90,4%	90,7%	88,4%	83,0%	5,7%	3,9%
	Read words	91,7%	91,3%	91,8%	83,1%	8,3%	2,6%
	Reading comprehension	87,6%	90,3%	90,0%	81,5%	11,1%	6,6%
	Arithmetic	80,1%	84,9%	82,3%	75,9%	11,2%	5,4%
2nd grade	Spelling [c)]	86,8%	86,0%	88,4%	83,6%	4,1%	2,0%
	Read words	89,1%	84,0%	94,4%	84,1%	5,2%	1,7%
	Reading comprehension	81,7%	84,2%	84,3%	85,7%	1,0%	6,2%
	Arithmetic	84,3%	85,7%	85,2%	84,2%	2,4%	6,0%
3rd grade	Spelling [c)]	87,8%	88,0%	88,9%	87,3%	1,9%	0,5%
	Read words	88,2%	87,7%	88,4%	80,3%	7,6%	0,8%
	Reading comprehension	88,7%	91,0%	88,8%	85,1%	6,0%	-0,7%
	Arithmetic	94,5%	86,5%	89,9%	87,2%	-5,4%	-15,3%**
Number of schools [a)]		**2 schools**	**18 schools**	**3 schools**	**18 schools**		

Note: The significance is tested by a two-tailed independent T-test with equal variance of 10%, 5% and 1% significance level. If a number does not include asterisks, there is no statistical difference.

[a]Bekkestua Primary School is only included in the post-measurement. Therefore, there are two schools in the pre-measurement and three schools in the post-measurement. [b]The difference is listed in percentage points. [c]In the first step, six parameters are usually measured. In this analysis, we have only used the words "Spell words" (spelling), "Read words", and "Reading comprehension". Consequently, "writing letters", "finding sounds in words", and "joining sounds" is not included in the analysis for the first grade, although this is also part of the state survey. For the second and third grades, we have omitted "Understanding words".

*with 90 % certainty there is a difference between the effort group and the control group. **with 95 % certainty there is a difference between the effort group and the control group. ***with 99 % certainty there is a difference between the effort group and the control group.

The table gives no clear conclusions. In general, effect sizes for first and second grade are positive both for 2015/2016 and 2017, but none of these can be considered to be different from zero. For the third grade, there was a significant negative effect in 2015/2016 on arithmetic. The effect is still negative in 2017, but we cannot conclude with statistical certainty that this is different from zero. This can in itself be regarded as a positive development.

Effects for Group 2 in First Through Third Grade

Table 10 shows the percentage of students above the critical boundary in the state assessment tests for reading, where we have selected the spelling, reading words, and reading comprehension among multiple subtests, and the state survey tests for pilot 2 schools and other schools in Bærum. A positive value in the column "diff-in-diff" indicates a positive effect of introducing tablets.

Table 10
Difference-in-difference Analysis of Share of Students above Critical Limit: First, Second, and Third grades (Group 2)

		Before tablet (2014,2015)		After tablet (2016,2017)		Effect (2016,2017)
		Pilot schools	Non-pilot schools	Pilot schools	Non-pilot schools	Diff-in-diff[b)]
1st grade	Spelling [c)]	90,4%	88,5%	90,8%	85,4%	3,5%
	Read words	89,6%	88,8%	92,3%	85,2%	6,3%*
	Reading comprehension	89,3%	88,0%	93,3%	84,8%	7,2%*
	Arithmetic	85,5%	81,2%	89,4%	79,2%	5,8%
2nd grade	Spelling [c)]	85,6%	86,2%	86,3%	84,6%	2,3%
	Read words	86,1%	84,4%	88,3%	84,6%	1,9%
	Reading comprehension	83,7%	86,9%	86,1%	84,4%	5,0%
	Arithmetic	86,7%	86,2%	84,8%	83,0%	1,3%
3rd grade	Spelling [c)]	88,2%	88,0%	90,2%	86,0%	4,0%
	Read words	89,0%	86,4%	85,0%	80,9%	1,4%
	Reading comprehension	92,7%	91,1%	92,1%	87,9%	2,6%
	Arithmetic	88,2%	87,4%	87,6%	86,8%	0,0%
Number of schools [a)]		**7 schools**	**18 schools**	**7 schools**	**18 schools**	

Note: The significance is tested by a two-tailed independent T-test with equal variance of 10%, 5% and 1% significance level. If a number does not include asterisks, there is no statistical difference.

[a]The number of schools is not equal to the number of observations. There are double numbers of observations in both the pre-measurements and the post-measurements, as both measurements extend over two years, i.e. all schools are included twice. The test in reading is, however, an exception, as only 2016 is included in the reassessment. [b] The difference is listed in percentage points. [c] In the first step, six parameters are usually measured. In this analysis, we have only used the words "Spell words" (spelling), "Read words", and "Reading comprehension". Consequently, "writing letters", "finding sounds in words", and "joining sounds" is not included in the analysis for the first grade, although this is also part of the state survey. For the second and third grade, we have omitted "Understanding words".

*with 90 % certainty there is a difference between the effort group and the control group. **with 95 % certainty there is a difference between the effort group and the control group. ***with 99 % certainty there is a difference between the effort group and the control group.

The table shows only positive effect sizes, but only two of the results can be considered to be different from zero. There are positive effects on reading and understanding in the first step, both of which are statistically significant.

4.1.8. Results from the Student Survey at Primary School and Secondary School

Effects for Group 1 in Seventh Grade

Table 11 shows the effect of introducing tablets in seventh grade for Pilot 1 schools compared to the other schools in Bærum. A positive value means that Pilot 1 schools have had an increase as compared to the other schools.

Table 11
Difference-in-Difference Analysis of Student Survey Indicators, Seventh Grade (Group 1)

	Effect (2015)	Effect (2016)	Before tablet (2014)		After tablet (2017)		Effect (2017)
	Diff-in-diff	Diff-in-diff	Pilot schools	Non-pilot schools	Pilot schools	Non-pilot schools	Diff-in-diff
Academic challenge	-0,10	-0,10	4,30	4,20	4,25	4,28	-0,13
Learning environment	0,12	0,00	3,90	3,75	3,80	3,79	-0,14
Bullying	-0,09	0,00	1,25	1,21	1,30	1,23	0,04
Mastery	0,01	0,06	4,10	4,08	4,00	3,90	0,08
Motivation	0,01	0,23	3,60	3,63	3,65	3,48	0,20
Enjoyment	0,05	0,20	4,20	4,24	4,30	4,13	0,21
Common rules	-0,04	0,01	4,00	3,76	4,00	3,84	-0,08
Teacher support	0,15	0,16	4,00	3,93	3,95	3,86	0,01
Home support	-0,15	0,08	4,10	4,08	4,10	4,10	-0,03
Assessment for learning	0,00	0,25	3,25	3,25	3,40	3,15	0,25
Number of schools			2 schools	8 schools	2 schools	8 schools	

Note: The significance is tested by a two-tailed independent T-test with equal variance of 10%, 5% and 1% significance level. If a number does not include asterisks, there is no statistical difference.

In the student survey, the students respond on a scale from 1 to 5. The 10 indicators are based on a number of sub-questions. The composition of the indicators is described in more detail at www.skoleporten.udir.no.

*with 90 % certainty there is a difference between the effort group and the control group. **with 95 % certainty there is a difference between the effort group and the control group. ***with 99 % certainty there is a difference between the effort group and the control group.

The table shows that there are no major differences in the student survey between Pilot 1 schools and other schools. By 2015, there was a significant effect to be found in the indicator bullying, which means that Pilot 1 schools had experienced a significant increase in bullying from 2014 to 2015. The bullying indicator is still higher for pilot schools than for other schools in 2016 and 2017, but the effect is no longer significant, which means we cannot conclude that the effect of tablets on bullying is different from zero. This means that there was a negative effect of tablets in the short term, but that effect has decreased and ceased in the long run. In addition, we cannot rule out that the impact on bullying in 2015 was influenced by a possible grade effect and other conditions, which are not related to the introduction of tablets.

To investigate the bullying results more closely, we examined the question about digital bullying in the National Student Survey (The Norwegian Directorate of Education and Training, 2018) between Group 1 and Group 2 and other schools in Bærum in 2016 and 2017. We found no significant differences in level and development between these school groups – neither combined, nor between genders. This can also be an indication that identification of bullying among girls in seventh grade in Pilot 2 schools depends on variables in addition to the usage of tablets.

Effects for Group 1 in Tenth Grade

Table 12 shows the effect of introducing tablets in the tenth grade for Pilot 1 schools as compared to the other schools in Bærum. A positive value means that pilot 2 schools have had an increase as compared to other schools in the other groups.

Table 12
Difference-in-difference Analysis of Student Survey Indicators, Tenth Grade (Group 1)

	Effect (2015)	Effect (2016)	Before tablet (2014)		After tablet (2017)		Effect (2017)
	Diff-in-diff	Diff-in-diff	Pilot schools	Non-pilot schools	Pilot schools	Non-pilot schools	Diff-in-diff
Academic challenge	-0,10	-0,10	4,30	4,20	4,25	4,28	-0,13
Learning environment	0,12	0,00	3,90	3,75	3,80	3,79	-0,14
Bullying	-0,09	0,00	1,25	1,21	1,30	1,23	0,04
Mastery	0,01	0,06	4,10	4,08	4,00	3,90	0,08
Motivation	0,01	0,23	3,60	3,63	3,65	3,48	0,20
Enjoyment	0,05	0,20	4,20	4,24	4,30	4,13	0,21
Common rules	-0,04	0,01	4,00	3,76	4,00	3,84	-0,08
Teacher support	0,15	0,16	4,00	3,93	3,95	3,86	0,01
Home support	-0,15	0,08	4,10	4,08	4,10	4,10	-0,03
Assessment for learning	0,00	0,25	3,25	3,25	3,40	3,15	0,25
Number of schools			2 schools	8 schools	2 schools	8 schools	

Note: The significance is tested by a two-tailed independent T-test with equal variance of 10%, 5% and 1% significance level. If a number does not include asterisks, there is no statistical difference.

In the student survey, the students respond on a scale from 1 to 5. The 10 indicators are based on a number of sub-questions. The composition of the indicators is described in more detail at www.skoleporten.udir.no.

The table shows, as in the seventh grade (Group 1), that the effects of introducing tablets on the student's well-being and learning environment are close to zero and not significant.

Effects for Group 2 in Tenth Grade

Table 13 shows the effect of introducing tablets in the tenth grade for pilot 2 schools as compared to other schools in Bærum. A positive value means that the pilot 2 schools have had an increase as compared to the other schools. The table shows, unlike in the seventh grade in pilot 2 schools, that the introduction of tablets has not had a negative impact on the bullying indicator for tenth-grade students. At the same time, we register positive significant effects on mastering, motivation, well-being, teacher support, and assessment of learning.

Table 13
Difference-in-difference Analysis of Student Survey Indicators, Tenth Grade (Group 2)

	Before tablets (2014,2015)		After tablets (2016,2017)		Effect
	Pilot schools	Non-pilot schools	Pilot schools	Non pilot schools	Diff-in-diff
Academic challenge	4,32	4,26	4,42	4,29	0,08
Learning environment	3,68	3,79	3,97	3,82	0,25
Bullying	1,20	1,21	1,22	1,22	0,00
Mastery	4,00	4,07	4,03	3,96	0,15*
Motivation	3,53	3,61	3,62	3,49	0,2**
Enjoyment	4,17	4,27	4,33	4,18	0,25**
Common rules	3,75	3,83	3,93	3,84	0,17
Teacher support	3,87	3,94	4,03	3,89	0,22*
Home support	4,03	4,11	4,17	4,10	0,14
Assessment for learning	3,17	3,26	3,42	3,15	0,36***
Number of schools	3 schools	8 schools	3 schools	8 schools	

Note: The significance is tested by a two-tailed independent T-test with equal variance of 10%, 5% and 1% significance level. If a number does not include asterisks, there is no statistical difference.
In the student survey, the students respond on a scale from 1 to 5. The 10 indicators are based on a number of sub-questions. The composition of the indicators is described in more detail at www.skoleporten.udir.no.
*with 90 % certainty there is a difference between the effort group and the control group. **with 95 % certainty there is a difference between the effort group and the control group. ***with 99 % certainty there is a difference between the effort group and the control group.

4.1.9. On the Use of Data from National Tests, National Mapping Survey, and the National Student Survey

We repeat that it is important to note that the effect results from national tests, the national mapping survey, and the National Student Survey (The Norwegian Directorate of Education and Training, 2018) belong to different students in the pre-and post-measurements. This means that the results from the effect measurements may potentially be the result of possible grade effects. Analyses and further investigation of the results of national tests in the eighth and ninth grades showed that the results here were quite robust in regard to the grade effect, while the analysis of the state mapping tests showed that the results here were not robust in regard to the grade effect. Therefore, we cannot rule out that the grade effect may also have an impact on the results in the student survey in the seventh and tenth grades. We therefore request that the results be read with this reservation.

5. Discussion

The context for this study has been the implementation of tablets as a part of the school development in the Bærum Municipality. As Fullan (2001, 2013) mentions, it can be a challenge to carry out school leadership in a culture of change, and the study has revealed several obstacles in this implementation process of tablets in school (this is described more thoroughly in the main report by Berrum, et al. 2018).

The study shows that in several school areas, tablets have a rather limited effect on pupils' learning outcomes. It is important to underline that the study does not find any direct causality in the relationship between implementing tablets and positive learning outcomes.

However, among the significant findings in this study, we see that tablets have somewhat more positive effects among boys than among girls. The positive effect of tablets that we see among boys can be related to the fact that the use of tablets serves as a positive structuring factor for the boys' learning work. We also find support for this in the 10^{th} grade, where boys who make use of tablets to a significantly greater extent experience having common rules for the teaching than boys in schools that do not use tablets. This may be because use of the tablet requires structure (we also find support for this in the qualitative interviews in the study). One possible explanation here can be that teachers make greater use of and make available work schedules and learning resources for school hours with the use of tablets. At the same time, the use of tablets contributes to the pupils having most of their tools and previous learning work gathered in one place in the tablet. This means that the pupils can get started quickly, and that they experience the learning resources as more transparent and accessible. We also find support for this in the qualitative data in the study.

Furthermore, it seems that the tablet can be a motivating factor in the pupils' school life. In this regard, we see significant positive findings in the 10^{th} grade, generally for increased motivation. It seems here that the tablet device helps to make boys more motivated for learning with the use of tablets. It can also be that the tablet's multiple digital, graphic, auditory and visual capabilities and support features (visualization, audio, multimodal aspect, communication capabilities) can give new opportunities for adapted education and differentiation. There is also the possibility that the tablet device provides the opportunity for a digital support that particularly benefits low-performing students, where boys are over-represented.

Does the tablet have an equalizing effect between the sexes? And can the use of tablets in schools thus contribute to a school with less difference between girls' and boys' school performance? Today, girls generally perform better than boys, and several studies reveal that there is not any "quick fix" for increasing boys' school performance with or without educational technology. However, findings from the study suggest the possibility that boys benefit from tablets to a greater extent than girls. An interesting finding is that the effect of introducing tablets is significantly positive for boys in fifth grade in English (as in 2015/2016). Furthermore, the effect is also positive and significant for all children in fifth grade in English in 2017. These findings can be based on a number of explanations (e.g., the gaming culture among boys, etc) where tablets might only be one of several factors. In general, the study shows that the large schools especially have positive results.

From a critical point of view, one might ask if this extensive use of digital tools both in school and outside school affect pupils writing skills with pen and paper (van der Meer & van der Weel, 2017). The study has not examined this area, but it is important for future research to raise the awareness around such digital “pitfalls”.

6. Conclusion

It is still too early to say anything definitive about the effect of tablets on learning outcomes, as changes take time. We refer therefore to the effects we see in the Pilot 1 schools as "intermediate effects".

The preliminary results give reason to assume that in several subject areas, tablets have a rather limited effect on pupils’ learning outcomes. However, the use of tablets can have some small positive effects on boys' learning. This can be linked to the fact that the tablet provides poorly performing students, where boys are over-represented, a digital support that contributes to smoothing the students' performance. This also presupposes an appropriate use of tablets and good teaching quality (in line with Genlott & Grönlund, 2016). The use of the tablet is strongly linked to pedagogical practice, which in turn is influenced by teacher competence. This might also link to “outside school learning” where the significantly positive results for boys in fifth grade in English can be interpreted as “a sign of the times” where English language immersion in leisure time among boys is continuously developing.

From the study, we find some tendencies that when the use of tablets is supported by teachers who have digital competence, their use seems to have a small equalising effect between the school achievements of boys and girls. However, we cannot rule out that a grade effect may also have an impact on the results, and we therefore request that the results be read with this reservation.

7. Limitations

There are some limitations in this study. First, in this part of the trailing research, we have only presented quantitative data. This might be a certain limitation since the research consists of several other data sources which give a broader picture of the implementation of tablets in Bærum Municipality.

Acknowledgements

We would like to thank Johanne Fyhn and Øystein Lorvik Nilsen for their contributions to this study. We would also like to thank Bærum Municipality and Rambøll Management for giving us the opportunity to carry out trailing research on the “Everyday Digital Schooling” pilot project. Finally, we would like to thank the University of Bergen and the project “Digital competence in higher education” for their support.

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Editors' Note: The authors have identified this as a work in progress and could not shorten it for our proceedings or alter tables created in a different language. As a result, some tables are screen captures and some data appears with non-UK numbering conventions.

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A ROBOT AS A TOOL FOR COGNITION

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Abstract

Various kinds of robots are available for use in education; however, their mere availability should not be enough reason to use them as a learning tool. Different types have different appearances, structures (hardware), systems (software) and functions (behavioral outcomes). These features serve an important role in determining the curricula, the instructional activities, and the learning objectives. The suitability of a robot as a learning tool depends on how it fits into a learner's environment, the role it plays and how learners engage with it in order to achieve a learning objective. This study presents a theoretical framework, key research areas, and practical examples of how we use robots in practical learning examples both in an academic educational environment and in industry. Challenges and benefits are discussed.

Introduction

Teaching and learning robotics is becoming an important subject and has gained special attention from educators and researchers. Robot education aims to provide learners with practical experiences for understanding technological and mechanical language of systems, accepting and adapting to constant changes driven by complex environments, and utilizing knowledge in real situations or across time, space, and contexts (Verner, Waks & Kolberg, 2009). Comprehensive and detailed studies of properties of robots, their roles and how learners actually engage with educational robots in line with their learning objectives are needed.

In this paper, an analytical overview of educational robotics is presented followed by a suggestion for a categorization of educational robots. The aim of this overview is to firstly provide a summarized description of educational robotics and to understand the foundations that underlie this prevailing field of robots in education. The research in the area covers a vast space across the theories, the levels of studies, robot types, setting and the subject domain. Secondly, the overview should help identify the different roles that robots play in the field of educational robotics, and how they influence the learning objectives and engagement of learners. Thirdly, the overview elaborates on the role of robotics and the robot as a tool for teaching and learning. The gaps that exist in the use of a robot as a tool for cognition are highlighted. At last, based on literature, a full-value robot system that would serve as a tool in learning and teaching is proposed and defined. We will also use a few different practical examples from our robotics education to try to highlight how to practically access a full value-like system.

Method

This study starts by reviewing existing studies and literature on educational robotics. To establish a reliable review, we used the systematic review process suggested by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, 2009) and as used by Jung and Won (2018). To collect relevant studies, six explicit criteria were set based on the following keywords: contents, research type, technologies, research setting, targeted academic level, and publication type. Each research study was comprehensively reviewed for the following key characteristics: type of robots employed, theoretical frameworks underlining the study, the learning environment, the subject or modules taught, and the role the robot played in meeting the learning objective.

The second part of the paper is based on observations in academic education of robot master students during a time span of two years as well as education within industry when transforming from manual to automated assembly. Lessons learned and how different types of robots can be used for educational purposes are described.

Theoretical Assumptions

The main theoretical assumptions or frameworks that are mainly employed widely across the reviewed studies are: Piaget's constructivism (Piaget, 1973), Papert's constructionism (Papert, 1980) and Vygotsky's ZPD (1986). Piaget and Papert's theories are used as the foundation of the rationale of educational robotics.

Piaget (1973) argues that manipulating artefacts is a key for learners to construct their knowledge. This suggests that hands-on experimentation is the essential basis for cognitive development. Papert's work (Papert, 1980) is as a natural extension to Piaget's work, but adds the idea that knowledge construction happens especially effectively in a context where the leaner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a technological artefact. Vygotsky, on the other hand, viewed knowledge as a process, which basically depends on technological and cultural scaffolding i.e., breaking up complex tasks into smaller tasks, a common occurrence in robotics education. The artefact becomes an "object to think with", which can be used to explore and express ideas that are related to the field (the thing) under investigation. For instance, robots can be used as an educational tool for artificial life and biological investigations, as described by Miglino, Lund, and Cardaci (1999).

These theoretical frameworks have underlined the basis with which curriculums in educational robotics are designed and implemented as they provided thick information about robotics curricula, teaching methods, and learning environments, thereby contributing heavily to building solid pedagogical foundations for most studies (Alimisis, 2012). In a systematic review by Jung and Won (2018), these theories have been extensively juxtaposed to research reviewed in the appendix section, hence giving a clear picture on how dominant the frameworks are in studies.

It is also important to mention that analogous to the theory of constructionism lie the principles of active learning (Harmin & Toth, 2006) and learning by design (Goldman, Eguchi, & Sklar, 2004) that advocate a hands-on approach to increase the motivation of learners. Such paradigms are well suited to the field because by their very nature "most" robots are tangible and require to be physically manipulated as part of the learning activity. Interacting with tools and artefacts also accords with the concept of the extended mind (Clark & Chalmers, 1998).

Jung and Won (2018) narrowed down the theories of learner engagements into a technical deterministic paradigm. This kind of determinism tends to simplify the interactions of learners with robot artefacts as unidirectional and decontextualized, rather than bidirectional and content specific; therefore, the engagement of learners with educational robotics and their participation from a social, cultural, political and historical perspective may have been ignored. This then suggests that the studies focus more on the expected results of a learning activity rather than the process, which is important in understanding how robots aid in cognitive development.

Subjects, Topics and Level of Study

Robots are used both in technical education and non-technical. In most cases of technical education, especially in lower levels of study, this is done to introduce the concepts of computer science and programming to familiarize the students with technology in general (Balch et al., 2008). The pupils are introduced to the use of robots and eventually light programming tasks, before being able to apply their full knowledge practically. As these subject areas progress, the activities become more hands on and often involve constructing and building robots (Barker & Ansorge, 2007). This hands-on approach has been shown to provide a strong sense of ownership and enhanced interest among learners (Mubin, Bartneck, Feijs, Hooft van Huysduynen, Hu, & Muelver, 2012). Educational robotics fosters learning of technology and science through the design, analysis, application and operation of robots and their systems (Verner, Waks, & Kolberg, 2009).

In non-technological areas, the robots are used as tools to impart knowledge to students. In subjects such as mathematics and geometry, the movement of robots is typically the main principle upon which the learning is based (Highfield, Mulligan, & Hedberg, 2008), whereas in biology, the robot acts a form of artificial life and biological representation to enable biological investigations (Miglino, Lund, & Cardaci 1999). In literature, robots are used to teach a second language or music. For example, in Japan children were taught English by the Robovie robot (Kanda, Hirano, Eaton, & Ishiguro, 2004), and in Korea children were taught music using the Tiro robot (Han, Kim, & Kim, 2009). Robots are now socially assisting in the cognitive and intellectual development of children as well (Kanda, Hirano, Eaton, & Ishiguro, 2004).

Educational robotics is highly utilized in low levels of study mainly because it is considered as a means of cultivating the engineering thinking in schoolchildren and developing their interest in technical creativity (Ospennikova, Ershov, & Iljin 2015).

At higher levels of study, colleges and universities, educational robotics is used to teach robotics itself as an independent subject. At this level there are two focuses: (1) contributions to the learning of concepts/subjects; and (2) skill development/improvement through robotics (Spolaôr & Benitti, 2017). The use of robots in education is either intra-curricular or extra-curricular.

Intra-curricular activities are part of the school curriculum and a formal part of the syllabus. Even a robot competition could be part of formal learning, as an assessment-based learning (Almeida et al., 2000). Extra-curricular learning is generally more relaxed and takes place after school hours, as workshops under the guidance of instructors, at home under the guidance of parents or just self-discovery.

Role and Behaviour of Robots Used

A robot can take a number of different roles in the learning process, depending on the level of involvement of the robot during the learning task. The choice depends on the content, the instructor, type of student (mainly defined by the level of study) and the nature of the learning environment (the area of study and setting). Two main perspectives exist when establishing these roles.

The first perspective regards robotics as a means or technological environment to teach other subjects. Here the focus is mainly on motivating young learners to grow their interest in a subject and to provide a tangible platform for learning (Jung & Won, 2018). The robot in this case can take the role of co-learner, peer or companion and normally has an active spontaneous participation (Okita, 2009).

The second perspective regards robotics as a tool to teach robotics itself. This positions robotics as a discipline by itself, or in some cases coupled with computer technology, and is mostly common at higher levels of study. Here the robot takes a passive role, is used a teaching aid or is the object of study in itself. Building, programming and operating robots are normally the main learning activities that surround this view of educational robotics.

However, upon analysis, it is evident that a clear mapping is not drawn out linking the learning activity to the interaction style of the robot. Mubin, Stevens, Shahid, Al Mahmud, & Dong, (2013) continue to explore this path as they investigate the degree of social behavior required by the role that a robot plays in the learning environment.

Classifications of the Educational Robot

Different types of robots have different appearances, structures (hardware), systems (software) and functions (behavioural outcomes) (Benitti, 2012).

These features play an important role in determining the curricula, the instructional activities, and the learning objectives. According to Russell and Norvig (2003), educational robotics is a wide range of robot technologies used for teaching and learning, which range from toy-like constructions to state-of-the-art robotics (Virnes, 2014). To define the educational robot, properties derived from hardware, software and the action environment of the robot are used (Russell & Norvig, 2003). It is also widely agreed that educational robots have different built-in pedagogical solutions that direct learners to certain actions and which help them learn the different subjects and modules. According to Shin & Kim (2007), educational robotics as learning tools aim at providing novel and extended possibilities to learn with, from and about educational robotics.

Most high-level education in robotics emphasizes industrial robots and hence uses products from industrial robot manufacturers as tools for the curricula. Low level robotics in primary and high schools mainly uses social robots and robot toys as it focuses more on interaction (Virnes, 2014). Another important classification of robots for education is robotics kits. Unlike other classifications, robotics kits allow students to create, build, and/or program robots (Virnes, 2014). Robot kits in this case give a broader view of a robotics learning environment as they engage a learner through designing, constructing and programming (operating) robots.

Robotic Toys

Robotic toys are generally presented as single model artefacts with limited features and mostly focus on form in a learning activity, meaning the physical appearance of the toy heavily guides or determines the application. They are widely available and ready to use for play and/or entertainment. Toy robots may imitate advanced social robots in their appearance and functions, but their implementation is based on lower-level technologies.

Robot Kits

Robot kits are programmable construction kits for building and programming a robot artefact. They consist of building blocks for creating a robot and a programming environment with a graphical user interface to create functions for the robot. A robot kit can vary from simple building blocks to advanced platforms but often imitates industrial robots and other advanced technologies (Virnes, 2014). They exist in different product variations, such as the famous LEGO Mindstorms by LEGO Group, The Bioloid STEM standard Kit by Robotis Bioloid, and the most recent ones, the Arduino Robot kit by Arduino.

Social Robots

Social Robots are single model artefacts that exist as autonomous robots and are able to recognize other, communicate and engage in social interaction (Fong, 2003). State-of-the-art social robots have primarily been developed to improve robotic devices, artificial intelligence and human-robot interaction. The educational context is often mentioned as a potential of application (Shin & Kim 2007), often as agents to teach subjects that require engagement in social interaction. Compared to toy robots and robot kits, social robots are pre-constructed and pre-programmed with an emphasis on learning through active social interaction and communicate by following social behaviors and pedagogical practices attached to their role. To achieve this effectively, an applied artificial intelligence has to be used through educational software applications (Tanaka, 2005). Fong, Nourbakhsh, & Dautenhahn (2003) define a wide range of social behaviors that make a robot social, like: express and perceive emotions, communicate using high-level dialogue, establish social relationships, exhibit a distinctive personality, and use natural cues (gaze, gestures, etc.). Examples of social robots are: Robota and Kapsar, used in mediating social interactions with children on an autistic spectrum in the context of therapy and education (Robins & Dautenhahn, 2010).

Industrial Robots

Industrial robots are considered the classical form of robots in educational robotics and their definition is more inclined to their industrial nature. According to the Robotic Industries Association (RIA ANSI/RIA R15.06-2012), an industrial robot is defined as *"A programmable, multifunctional manipulator designed to move materials, parts, tools or special devices through programmed motion for the performance of a variety of tasks"*.

Industrial robots are not widely adopted in the educational space and are mostly limited to learners already studying robotics. In education, learners program and analyze the robot and are not really involved in designing and building the robot as this is already done by those in industry and made available as commercial products.

Robot as a Tool for Cognition

Educational robotics provide active development of the entire complex of the cognitive processes, like perception, problem solving, imagination, thinking strategies, memory, and speech in learners. When looking at how learners engage with educational robots two distinct dimensions can be seen: (1) Technology-led action; and (2) Learner/user-led action. Combining the dimensions with the role and type of robot used in a learning setup four orientations can be identified: (a) implementation process driven action regarding industrial robots; (b) design process driven action regarding robot kits; (c) robot-driven action regarding social robots; and (d) encounter-driven action regarding a full-value educational robot (see Figure 1).

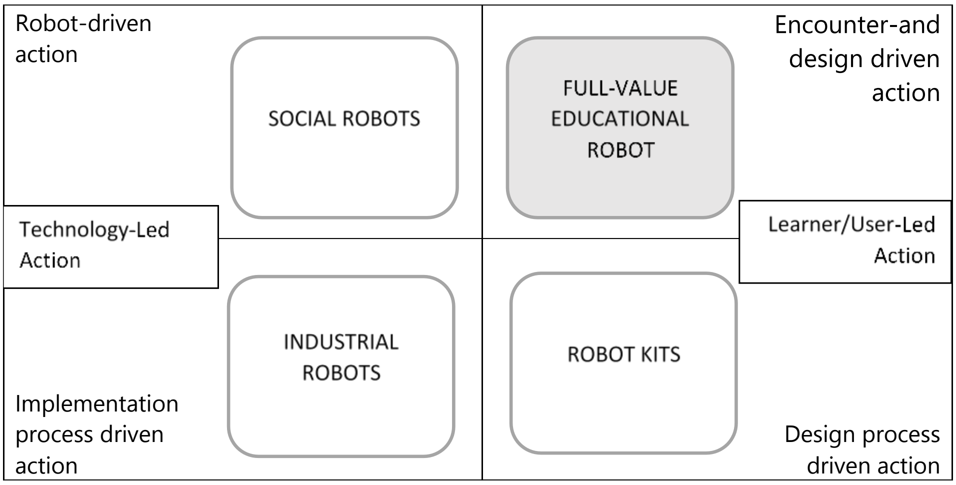

Figure 1. Categorization of educational robots – four categories describing how to divide robots based on learning outcome and how much ability the robot provide for the learner to experiment and investigate.

Industrial and Social robots are developed with objectives of improving or achieving set goals in their respective industries. Social robots improve artificial intelligence and human-robot interaction while industrial robots are built to support production spaces in manufacturing. These robots represent high degrees of technology in education and as such contribute to the technology-led action dimension. This standpoint emphasizes technical development before pedagogical design and the application of advance technologies into education. Learning from a social robot, for example, makes the user/learner an observer and imitator of the technology. Technology-led action is realized from an industrial robot, particularly when programming. Even though the learners can build various robot working environments and program the robot to manipulate its behavior, they do so from a manufacturer’s instruction manual. This makes the learners a recipient of the technology rather than a creator of the technology, and therefore their role remains as a user.

Learner/user led action in educational robotics is realized more with robot kits that allow learners to create artefacts more freely without specifications. Here, learners get to design, build and modify their creations freely as action is open-ended.

Defining a Full-value Educational Robot

What then would make up a full value educational robot as a tool for education? From the dimensions discussed, it is clear that both technology-led actions and user-led actions are needed to have a well-balanced learning tool. The tool has to provide ability to get in touch with existing technology and also allow users to be able to maneuver their way around this technology by examining them, understanding them and also be able to use what they have learnt to build upon their ideas through design. A full value robot is encounter and design driven. So far, most robots that exist appear as a black box, where the technology is closed and a learner can only be seen to learn what the robot has to offer. This is rather limited, as seen in industrial robots, which are used as an implementation and process driven tool.

A full-value robot system that involves modelling of robots and their systems both physically and virtually would likely be the best approach. Modelling is one of the important methods of cognition that exist, since with the help of models one can successfully study the properties and functionality of real technical objects. Modelling of designs and functionality of robots in a virtual environment enables engineers to find the most efficient conceptual and design solutions. Using special software, not only is modelling of robot constructions implemented, but also the development of their complete digital dummies. In connection to this, certain requirements are imposed on the software environments for the development of a robot kit: 1) opportunity to create a virtual model of robot similar to its real physical model; 2) opportunity to model virtually the behavior of a robot in an environment similar to the real physical world; 3) three-dimensional visualization model of a robot and its behavior in a virtual environment; 4) opportunity to use programs written for a virtual model of a robot for a real similar robot (Ospennikova et al., 2015).

A variety of designer kits in educational robotics have been created and try to implement full-scale modelling; these include Lego for education, Lego Mindstorms and Fun & Bot. However, in these kits, the ability to have a digital twin in form of a virtual model is very limited and therefore both the physical and computer modelling of such robots is distinguished. When teaching students (just like in the real scientific and technical research), technologies of full-scale and virtual modelling of robots, as a rule, have to be implemented jointly.

Practical experience

In our curriculum for teaching robotics to academic students, we try to combine different solutions to reach the effect of a full value system.

We have a full automated line (see Figure 2) with regular industrial robots where the students can learn how to program and use the robots individually first and then connect them and create an integrated system for a line setup. They start with the theoretical framework of how to logically understand the programing environment and coordinate systems of the robot. Practically they then implement first simple tasks and learn how to use the robot in practice. They then progress to more and more advanced assignments. They solve the tasks in groups so they can discuss and learn from each other and then the final tasks are assessed individually. We can observe that the students are much more active learners when they are allowed to physically access the robots. It is a process driven learning and based on hands on problem solving, which follows Piaget's theories quite well (Piaget, 1973). The students are also working with software like Robot Studio to create robot paths and actions. This allows them to model, test, simulate and design more advanced technical solutions.

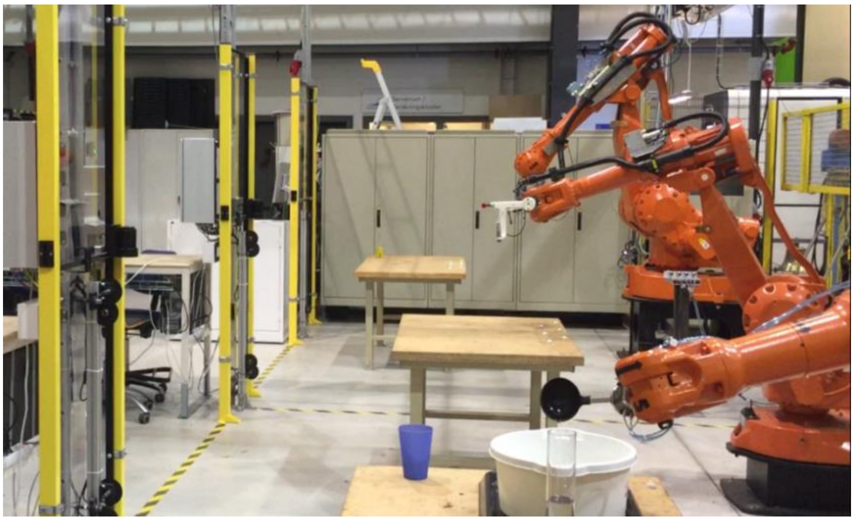

Figure 2. Three standard ABB Industrial robots in a university teaching lab, used by students in mechanical engineering and robotics educations to learn basic robotics.

In parallel to the physical robot lab we also have toy robots, a LEGO Mindstorm class set, which we use for conceptual design, problem solving and logic. The students design, construct and program the robots. Sensors can be attached for path finding and detection of outer world parameters. A graphical programing language is used to give instructions to the robot. This learning is more experimental and user driven but still very hands on.

By using combinations of these robots as learning tools we try to reach a full-value system. Part of robotics is also to understand design and construction of production lines; how to create a flow and a robot layout; how to make them cooperate. To understand process planning, we add an additional dimension by introducing a Virtual Reality (VR) environment. The learners can access CAD drawings and step into a realistic robot line to get an understanding of what they are building. Ergonomics, heights and positions can be evaluated physically. Also simple robot paths can be created from within the VR environment.

Educational robotics should implement active, constructive, intentional, authentic and cooperative learning manners (Jonassen, Howland, Moore, & Marra, 2003) and raise learners' engagement (Mishra, 2013), which we try to create within our education.

Conclusion

This review paper has presented a well-grounded summary of educational robotics while exploring all the aspects that make it a worthy area of study. It is clear that not only are robots built on advanced technology and help shape up technology-led actions but they also have the potential of providing tangible representation of learning outcomes: a valuable aspect of using them in education. An outcome of the review is to explore the role of robots as tools and to encourage pedagogical experts to further understand the practical aspects of the utilization of robots in education specifically in line with their technological properties, learners' engagement and the roles chosen for the robots to play. While typically, it appears that theoretical and pedagogical aspects of educational robotics are not given enough weight, this review tries to bring out the properties of a good educational robot and define what would make up a full-value robot system for education. Different perspectives could potentially be taken in researching this domain, for example, from the perspective of how the full-value robot would influence education focusing on learning outcomes, from technology focusing on design and development or from robot interactions focusing on the themes of learners' engagements with robots.

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DEMONSTRATING APPLICATIONS FOR LEARNING ANALYTICS FOR PROGRAM REVIEW

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Abstract

The Program Review Tool (PRT) has been developed to conduct program-level learning analytics. Examples of review outputs using the tool illustrate its value, showing how the PRT allows users to conduct analyses that provide insights for improving the curriculum and for supporting students during their studies. PRT analyses address questions about program progression and retention, factors influencing academic outcomes and how to improve the curriculum and subjects. With the PRT, users can conduct a standard review or explore program data themselves, making it a powerful yet flexible tool for enhancing program quality.

Learning Analytics Applications for Program Review

Learning analytics (LA) involves analysing data about learners to help improve learning outcomes. In this paper, a tool to support conducting data-driven program[1] review is discussed. Using this tool, the Program Review Tool (PRT), data about students' performance across all subjects in their program, from commencement to graduation, can be analysed. The PRT is designed to provide an assessment of the program as a whole and results can be used to inform what changes should be made to the program to improve the learning outcomes for students or improve the learning design or delivery. Developed as a Microsoft Excel add-in, the tool is easy to use, providing a high level of automation to the analyses while still giving users flexibility to explore the data. A standard set of review questions are addressed by analyses performed automatically using the PRT. These standard review questions and associated analyses address progress and retention rates for the program, the effect on academic performance of students' entry characteristics, what factors impact students' academic outcomes and which subjects require review or revision. Results from reviews are presented in this paper to illustrate the effectiveness of both the methodology and the tool for providing insights about the program and relationships between subjects, as well as providing information on how to support students to be academically successful. This work demonstrates the usefulness of analysing data about learners accumulated across their studies, and supports the application of LA not just to subjects, but to programs too.

Applications for Learning Analytics

LA is "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." (Siemens, 2013, p. 1382). Research on LA applications includes studies on institutional performance metrics, e.g., attrition and progression (Arnold & Pistilli, 2012), retention (de Freitas et al., 2015), predictors of academic performance (Gašević, Dawson, Rogers & Gasevic, 2016; Dede, Ho & Mitros, 2016), and analysis of datasets from learning management systems as proxies for student engagement (Gibson & de Frietas, 2016). LA techniques can also be applied to understand the causes of at-risk learning behaviors and for assessing institutional performance (Greller & Drachsler, 2012).

LA for Program Review

While subject and institution level applications for LA have been identified and studied, LA applied to programs is relatively under-explored. However, recently Armatas and Spratt (2019) described applications for LA for curriculum review of programs that include measuring the overall difficulty of a program, examining the relationship between subject difficulty and students' satisfaction with the teaching in the subject and comparison between student cohorts on measures of academic achievement. They note that the specialist skills that some LA techniques require may make it difficult for many academics to conduct program review using an LA approach. To address this challenge, we have developed the PRT, which can be used as part of a model specifically developed to conduct program review using LA. The model has four stages (Prepare, Map, Analyse and Implement; P-MAI) and is discussed next.

The P-MAI Model

In the first phase of the P-MAI model, *Prepare*, review questions, together with what data are available and what data need to be collected or obtained (and from where), are identified. The second phase, *Map*, is where data are linked to review questions and possible analysis strategies are identified. For each review question, there may be multiple data types or sources, multiple analysis strategies or both, so decisions need to be made about what analyses to conduct in the next phase. Examples of this mapping are shown in Table 1. Analysis of the data to address review questions is conducted in the third phase, *Analyse*, and the results interpreted and reported. The results are used to develop an action plan for the final stage, *Implement*, which includes a Program Diagnostic Report that details the findings from the review. This report includes answers to the review questions based on the analyses conducted in the previous phase, with recommendations for action, learning advice for students and advice for academic advisors.

Table 1
Examples of mapping of program review questions to analysis strategies

Program Review Questions	Possible Analysis Strategies
1. Are there issues with progression or retention across the program related to specific subjects or students?	• number of students graduated within the normal study period, graduated late or not at all • Identification of subjects with high fail rates • Identification of students with lower than expected performance or progression
2. What is the relationship between subject difficulty and student satisfaction?	• Correlational analysis and visualization (scatterplot)
3. What predicts students' academic performance in the program under review?	• Testing prediction models based on students' grades and overall academic performance (e.g., entry characteristics or subject grades).

Programme Review Tool

The PRT has been designed to support the P-MAI model as a tool to conduct complex analyses for program review without the need for specialized data analysis expertise. In this paper the focus is on the third phase of P-MAI, where a standard set of analyses are conducted using the PRT to address review questions in a structured fashion, with the user able to explore the data to address other questions that may arise after the standard set of review questions are addressed.

How the PRT Works

The PRT is designed to analyse the full academic records for a cohort, which is defined as a group of students who commenced study in a program in the same academic year and who would usually graduate together. Figure 1 shows the work flow for the PRT, which starts with importing the data set containing all the academic records for each student enrolled in that cohort, with the minimum information required being students' entry characteristics, what subjects they took, the semester in which they took the subject and the grade they received for each subject.

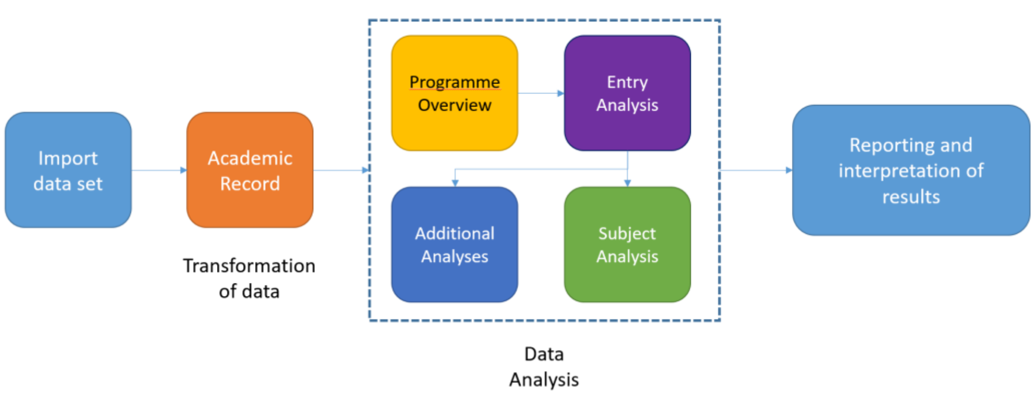

Figure 1. Workflow for the Program Review Tool.

At our University, students' academic records are provided in an Excel spreadsheet which has multiple rows for each student – one row for each subject they took during the program. Before importing these data into the PRT, the user needs to name the worksheet with the student information as "*Data*" and create another worksheet called "*Program Overview*" and provide information about what subjects are core (i.e., all students studying the program need to take these subjects), and the credit point value and duration (i.e., one or two semesters) for each core subject. The user then opens the PRT and a new menu item called "PRT" is added to the menu bar in the Excel file as shown in Figure 2.

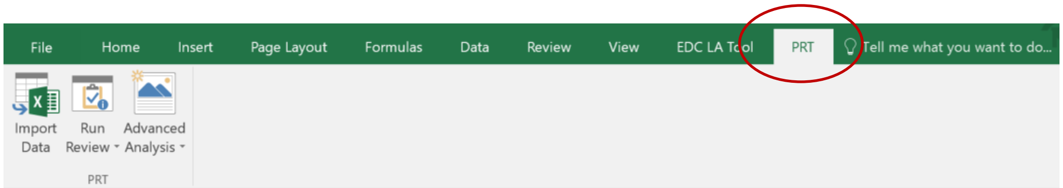

Figure 2. The *PRT* button is added to the menu bar when the tool is opened.

Clicking on this new button brings up three sub-menus: "*Import Data*", "*Run Review*" and "*Advanced Analysis*". The first step for any review is to import the data by clicking on the "*Import Data*" button. This brings up a window prompting the user to select the data for analysis by browsing to the file location, selecting the file and clicking OK. The data are then transformed and imported into the tool for further analysis. Transformation of the data is needed because the format of the data extracted from the University's student record system is not suitable for analysis - each student needs to have only one record (in this case a row in the Excel file) with the values for each variable recorded in columns. However, the student record extract has multiple rows for each student. Therefore, the workflow for the PRT involves importing the data in the original, multiple-row format and then transforming the data to produce an academic record where the data for a student appear in only one row in the file. After importing the data, a worksheet is produced in the Excel file called "*Academic Record*". This is a record of all data from the original data file that can be exported and used in other applications such as IBM SPSS Statistics[2] to conduct additional analysis not supported by the PRT. Once the academic record worksheet has been created, the user can then conduct analyses on the student data to address review questions such as the ones described in Table 1. Clicking on the *"Run Review"* button steps the user through a series of analyses mapped to review questions. How this process works and the outputs created using the PRT are described next, using actual program reviews.

Review Examples

Sample output from analysis of anonymized program data using the PRT for program review is provided next. These examples illustrate outputs from the tool and how this information can be used to address program review questions.

Overview of the Program

Clicking on the "*Run Review"* menu button generates an *Overview* worksheet with two tables and two charts. Figure 3 shows a screenshot of this information for a program review. The tables give information about the graduation status of students in the cohort and information about entry method[3], progression and retention. The graphs provide information about the average semester Grade Point Average (GPA[4]) and the average credit-points per semester. The user can control what information is displayed in the output for this worksheet. For example, the credit point threshold per semester can be adjusted to reflect the number of credit points students are expected to take each semester to graduate within the normal study period. A drop-down menu on the two charts allows the user to select which students (all students admitted to the program, those who graduated within the normal study period, those who graduate beyond the normal study period and those still enrolled) to display information about.

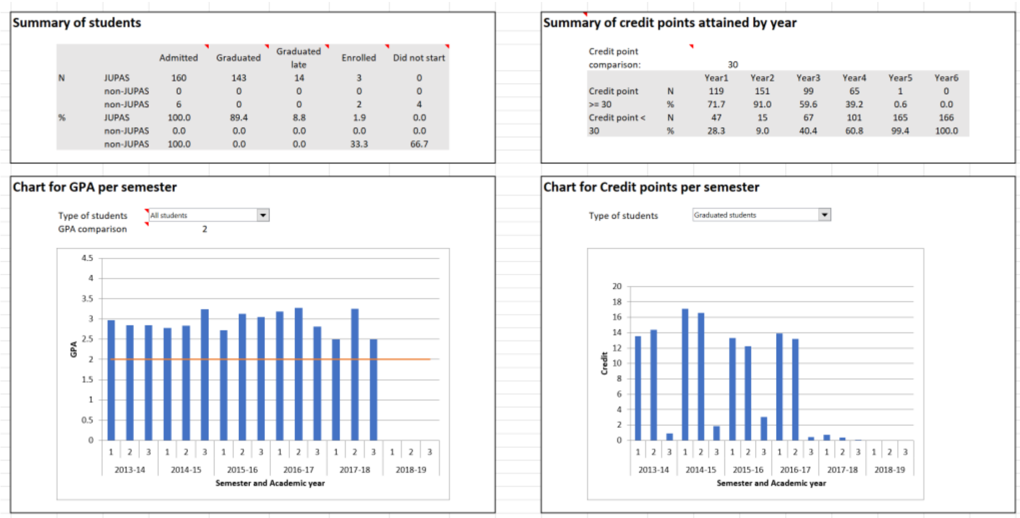

Figure 3. Sample output for the Overview worksheet.

Entry Analysis

Two worksheets are produced for the next analysis, which relate to students' entry characteristics – specifically their grades on the Hong Kong Diploma of Secondary Education (HKDSE). The first worksheet, called *Entry Analysis*, lists the subjects that individual students have taken for their HKDSE and the marks they received for each subject. This list can be used to see what subject combinations students admitted to the program take for their HKDSE and to conduct further analysis to look for patterns in subjects that students take and the relationship with the GPA they graduate with (Award GPA). The user can choose which subjects to include in the entry analysis via a dialogue window that opens when the *"Run Analysis"* button is clicked. The second worksheet has a table of descriptive statistics and a bubble scatter chart based on this table. Figure 4 shows a screenshot of this output for a program, where the user has included all subjects that students admitted to the program took for their HKDSE. In Figure 4, the large bubble size indicates a large proportion of students took Business Studies, Economics and Combined Science for their HKDSE, in addition to the required entry subjects of English, Chinese, Liberal Studies and Mathematics. There appears to be little relationship between Award GPA and grades for the HKDSE subjects as shown by the flatness of the bubbles in the chart. The exception to this is the small number of students who took Chinese Literature in HKDSE who got a relatively low score for this subject but achieved a relatively higher Award GPA on graduation.

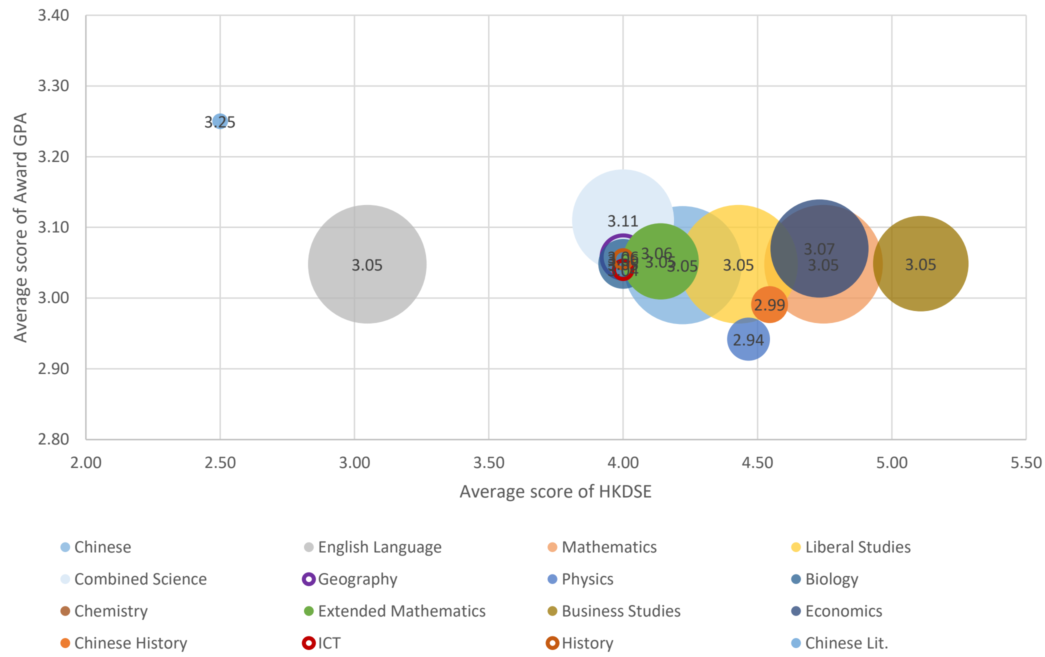

Figure 4. Output for analysis of students' entry characteristics. In the diagram, the size of the subject bubble indicates the proportion of students who took the subject, with the larger the bubble, the more students who took the subject.

The two worksheets produced for analysis of entry scores provide visualizations of subjects taken by students at HKDSE, the grades they received for them and what relationship this has with their academic performance as measured by Award GPA. The information about students' entry characteristics can also be used in advanced analyses the user may wish to conduct.

Subject Analysis

Results of subject analysis are displayed next. The first output is a series of spark charts of grade distributions for all core subjects. A sample screenshot of this output is shown in Figure 5. Displaying the grade distributions together allows visual identification of subjects that are too hard (e.g., ABC457, CDE123 and FGH124), ones that are too easy (e.g., ABC123, ABC223, FGH123) and ones that have too few grade categories (e.g., LMN345 and LMN346). This information informs decisions on which subjects should be reviewed or revised. The second output lists all subjects that one or more students in the program failed. This provides information about subjects that students may find challenging and can also be used to identify students who fail multiple subjects.

Subject	Student count	Grade Distribution A+ A B+ B C+ C D+ D F	Individual Grade Counts A+	A	B+	B	C+	C	D+	D	F
ABC123	138		4	24	45	42	18	5	0	0	0
ABC223	141		7	20	37	43	25	6	2	1	0
ABC224	162		2	11	33	57	36	19	2	0	2
ABC225	162		0	3	59	50	36	13	0	0	1
ABC226	162		5	19	38	49	25	16	9	0	1
ABC345	161		6	15	24	52	34	25	4	0	1
ABC346	160		11	14	28	49	27	23	6	2	0
ABC347	160		3	13	28	24	41	40	11	0	0
ABC348	160		2	13	33	55	27	24	4	1	1
ABC349	160		4	20	42	47	27	14	6	0	0
ABC350	160		8	23	46	52	19	7	4	0	1
ABC351	160		0	23	53	58	16	8	2	0	0
ABC456	159		11	25	41	41	20	12	7	2	0
ABC457	160		1	4	24	33	52	33	12	0	1
ABC458	160		8	33	38	42	25	7	6	0	0
ABC459	158		0	16	75	57	9	1	0	0	0
ABC460	159		3	30	49	65	7	1	4	0	0
CDE123	102		6	7	9	26	18	21	10	4	1
CDE124	145		6	14	36	44	26	14	3	1	1
FGH123	137		2	40	37	32	15	6	3	2	0
FGH124	137		3	9	12	36	47	26	2	2	0
IJK345	160		0	3	35	74	37	3	2	0	0
LMN345	161		0	0	23	95	42	1	0	0	0
LMN346	160		0	4	53	87	16	0	0	0	0

Figure 5. Distribution of grades for core subjects in the program.

The third output is a scatterplot showing the relationship between subject difficulty (as measured by average grade for the subject) and student satisfaction with the subject measured by the end of semester Student Feedback Questionnaire (SFQ) – a screenshot of sample output is shown in Figure 6. This visualization is useful as it shows which subjects are difficult and students are dissatisfied with (subjects that fall in the lower left quadrant of Figure 6) and those that are easy but students are still dissatisfied with (subjects in the lower right of Figure 6).

Scatter Plot of Score Grade and SFQ Score

Subject Code	Average Grade	SFQ Score
ABC123	3.282442748	4.074813
ABC223	3.186567164	4.095632
ABC224	2.915625	4.224758
ABC225	2.99068323	4.290648
ABC226	3.075163399	3.430837
ABC345	2.923566879	4.214085
ABC346	2.99025974	4.271669
ABC347	2.795302013	4.356998
ABC348	2.929487179	4.333046
ABC349	3.126760563	4.035357
ABC350	3.222972973	4.540669
ABC351	3.212025316	4.239597
ABC456	3.207482993	3.69682
ABC457	2.693877551	4
ABC458	3.287234043	4.481828
ABC459	3.340277778	3.850825
ABC460	3.341935484	3.5
CDE123	2.738636364	4.225559
CDE124	3.042253521	4.321329
FGH123	3.329545455	4.188333
FGH124	2.737037037	4.484848
IJK345	2.993421053	3.585953
LMN345	2.934375	4.112903
LMN346	3.140625	4.028388
FAC123	2.920634921	4.4
OPQ234	3.285714286	4.239597
RST123	2.870860927	3.69682
RST234	3.122137405	3.1
RST235	3.146496815	4.481828
RST236	3.146153846	3.850825
RST456	3.165467626	3.1

Table of descriptive statistics

Subject Level	Count	Mean	Standard Deviation	Maximum	Minimum	Mode
Level 1	4466	3.068406	0.598777	4	0	3
Level 2	905	2.998343	0.629517	4	0	3
Level 3	1152	3.10026	0.594041	4	0	3
Level 4	1536	3.026367	0.57368	4	0	3
Overall	873	3.172967	0.599486	4	0	3.5

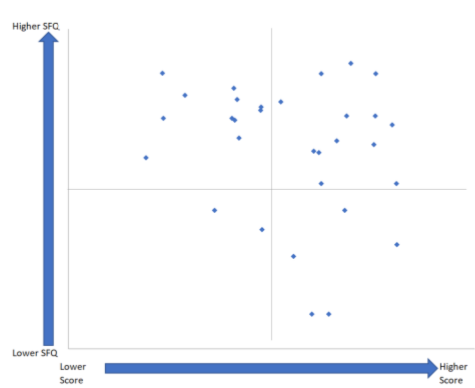

Figure 6. Summary statistics and scatterplot of the relationship between average subject grade and average subject satisfaction score (SFQ).

The output shown in the worksheets generated for *Subject Analysis* can help to address questions about which subjects students find difficult (e.g., the ones with high fail rates or low average grade), which subjects are too easy or difficult (e.g., the grade distributions are skewed to one or other end of the grading scale) and which subjects students are not satisfied with (e.g., have low average satisfaction scores on the SFQ). For those subjects identified from the spark charts of grade distribution, review of assessment practices and materials is required –a narrow range or skewed grade distributions can be addressed by examining the criteria for each grade level and ensuring that markers are applying the criteria consistently. In regard to subject satisfaction, students can be dissatisfied with a subject because it is too hard or too easy, but understanding why students feel this way and what to do about it requires further investigation.

Advanced Analyses

After the standard set of analyses have been run, the user can elect to conduct more advanced analyses. For example, under the *"Advanced Analysis"* menu, the PRT has a sub-menu item called "*Prediction*" which can be used to test models to address review questions of interest. A screenshot of the output from a model predicting Award GPA from HKDSE scores, grade in Freshman Seminar, GPA at the end of Year 1 and grade in Capstone project is shown in Figure 7. As shown in the figure, for this program, cumulative GPA at the end of Year 1 and grade in Capstone project (a major final year project) are significant predictors of Award GPA, while scores on the HKDSE and grade for Freshman Seminar (taken in first year) are not. Together, scores for these two variables account for 77.5% of the variance in Award GPA, which makes them strong predictors of this variable.

Prediction analysis results

Dependent Variable (i.e., what you are predicting) =	Award GPA
Variance in students' performance explained by these factors (R-square) =	0.775
Number of students included in the analysis =	157

Factors affecting dependent variable	Unstandardised Beta (B)	Standardised Beta (beta)	Significant Factors	Importance (Rank)
Score on HKDSE	-0.034	-0.048		
Grade in Freshman Seminar	-0.003	-0.01		
Cummulative GPA at the end of Year 1	0.524	0.699	Significant	1
Capstone Project Grade	0.114	0.385	Significant	2

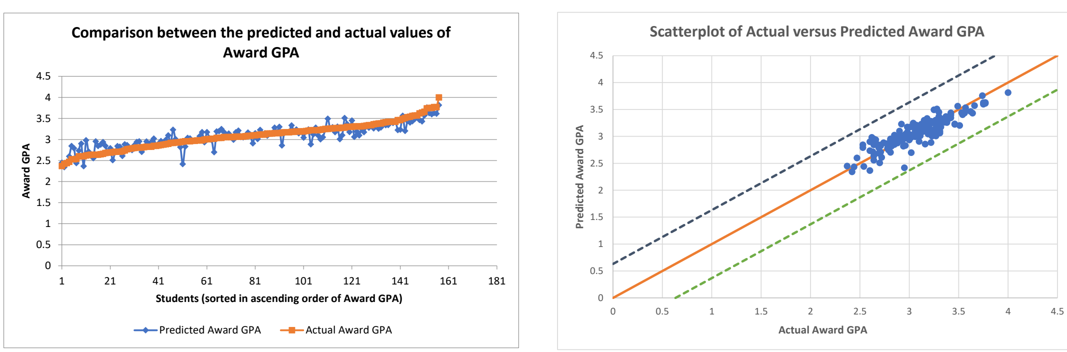

Figure 7. Example of results of regression analysis conducted using the PRT.

In addition to indicating which variables are and are not significant predictors of Award GPA, the two diagrams included with the output can be used to assess the adequacy of the model. The plot on the left of the actual Award GPA value against that predicted using the variables in the model shows good correspondence between the two, indicating this set of variables is a good predictor. This is confirmed in the diagram on the right of Figure 7 where all the points fall within the two boundary lines and fall on or near the reference line. Users are provided with visualisations such as this to help interpret the analysis results, which in this case indicate that while HKDSE score and grade on Freshman Seminar are not predictive of overall academic performance as measured by Award GPA, GPA at the end of Year 1 and Capstone Project grade are. This also highlights the importance of supporting students to be successful in first year to provide them with a foundation for future academic success.

Discussion

There are other analyses and outputs produced as part of the standard review which are not reported here due to space limitations. However, the examples provided illustrate in principle how the results from these analyses can be used to address review questions identified in the *Prepare* phase of the P-MAI. The PRT development is now at the stage where a full set of analyses can be conducted using the tool which address a predefined set of review questions, which have been developed in consultation with program leaders. To conduct a review using the PRT, the minimum information required is information about students' entry characteristics, study patterns and subject grades. Work is underway to help users turn the results into actions for improvement. Strategies to achieve this include development of resources such as videos and case-studies in collaboration with users who have conducted reviews using the P-MAI approach and the PRT.

Ultimately the usefulness of this approach will depend on whether results can be translated into actions that improve student learning. In its current format, the P-MAI approach evaluates a program based on the performance of a cohort who have already graduated. Therefore, any changes made to improve the program will happen too late to help those students. However, by understanding the factors that impact on the success of the students who have already graduated, it is possible to better support students currently enrolled in the program. The PRT makes it easier to conduct regular, data-driven program review, making it an important tool for program evaluation and quality enhancement.

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Notes

1. A “program” is an award or degree, consisting of core and elective requirements a student must complete to be awarded the degree. At our university, most undergraduate degrees have a four year duration.
2. IBM SPSS Statistics https://www.ibm.com/products/spss-statistics
3. Hong Kong Universities have two entry methods – JUPAS (Joint University Programmes Admission Scheme) and non-JUPAS. Students who complete the Hong Kong Diploma of Secondary Education (HKDSE) are categorised as JUPAS and all other students admitted are categorised as non-JUPAS.
4. GPA is a weighted average of the grades a student accumulates. Calculating GPA involves multiplying each numeric grade for a subject by its credit-point value, taking the sum and then dividing by the total number of credit points taken. At our university, GPA can range from 0 to 4 and is calculated on a semester and yearly basis, as well as at the end of the program (Award GPA).

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FOSTERING A CRITICAL APPROACH TO DIGITAL TECHNOLOGY IN GRADUATE LANGUAGE TEACHER EDUCATION AND POSTGRADUATE INTERDISCIPLINARY PROGRAMS

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Brazil

Abstract

In this paper, I debate the role of tertiary educators in legitimizing practices that foster the use of digital technologies in educational settings. Adopting the narrative inquiry as methodology and grounding the discussion in critical literacy studies, I present my own practical knowledge as a professor in a Brazilian university. My interpretation suggests that some of the graduate and postgraduate projects developed under my supervision have presented practical ideas leading to the adoption of a critical approach to language, technology and society. This favors and fosters citizenship and social justice approaches to foreign language education activities in Brazilian schools.

Introduction

Following digital advances in information communication and technologies – and mostly after Internet affordances were rapidly shared – there has been a sense of urgency towards technology innovation in educational settings across the world. For the last two decades, pre-service and in-service Brazilian educators have been working under pressure to integrate digital resources into their teaching routines, in order to ensure that educational practices meet the standards of a society permeated by Information and Communication Technologies (ICT). Santos Neto and Mill (2018), interested in exploring the connections between the intensification of teaching work and Distance Learning, conducted bibliometric research, investigating a single and specific digital bank of Brazilian Ph.D. theses in Education that were published between the years of 2002 and 2012. Their findings showed that almost one-third of a total of 3,468 thesis mentioned words related to digital technologies, either in the thesis title or key-words. Words such as "techno", "digit", "online", "compute", "Internet", "virtual", "cellular", "tablet" or "EAD" (the Brazilian Portuguese anagram for Distance Education) were evident. These researchers noted that the majority of the works in their findings were related to the use of ICT in pedagogical practices (Santos Neto & Mill, 2018, p. 130). Other important investigations have also tackled this issue. A recent survey on the use of information and communication technologies in Brazilian schools, conducted by the Brazilian Internet Steering Committee (Brazilian Network Information Center [BNIC], 2018, p. 242), found out that among the 1,430 consulted and sampled schools located in urban areas, 97% of the teachers reported using the Internet, mostly on mobile devices. The report explains that in a similar survey conducted in 2013, Internet use was reported in only 38% of the sample results. However, the same report confirms that among students there are still consistent inequalities as "even though 85% of students located in urban areas were considered Internet users (…), 22% of those who studied in public schools went online only via mobile phones, a percentage that was only 2% among private school students", meaning that those poorer students only had access to online technologies on their mobile devices. This shows us that there is still a huge gap between those learners who can pay for private schooling and those who have to attend public schools. As for the latter, there is still little to no access to Internet and/or hardware equipment at home and/or schools (BNIC, 2018, p. 164). Another relevant finding was that there was an increasing number of teachers who reported using mobile phones in pedagogical activities: 53% in 2017 against 36% in 2015 amongst public school teachers, and 69% in 2017 against 46% in 2015 amongst private school teachers (BNIC, 2018, p. 164). Moreover, the survey also points out the remaining challenges to overcome in order to implement ICT in rigorous and appropriate pedagogical practices in Brazilian schools. Teachers and principals interviewed said that there is still a lack of ICT professional development programs. They also mentioned significant issues relating to infrastructure, such as fewer computers than needed and a very limited, very slow to no Internet access in public schools (BNIC, 2018, p. 165).

Although the aforementioned results might reaffirm the premise that teachers have being consistently motivated to adopt and adapt digital technologies to their working routines, they also imply that there are still pressing issues to be discussed. As an example, there is the ongoing inequality found in terms of digital technology access amongst students coming from different social groups in Brazil. It is possible to infer that by allowing or denying access to multiple literacies and their affordances, we might be promoting changes or maintaining social inequities. This suggests teachers and tertiary professors educating teachers need to take a closer look at the use of the ICT in pedagogical activities. Some crucial aspects to be considered beforehand might relate to *the sorts of activities that should/could be developed, by whom, where and why*.

With this scenario in mind, the purpose of this paper is to stimulate a debate concerning the role and responsibilities of tertiary educators in fostering, during teacher education programs, emergent practices that validate the presence of digital technologies in a range of different educational settings. I drive this discussion from a brief literature review on some interfaces amongst technology, education and critical literacies. Therefore, the discussion offers a well-informed and critically-oriented interpretation, in the form of a narrative of my own practical knowledge, which is based on some of the dialogues and experiences I have shared with both graduate and postgraduate students whose final graduate papers and research projects I have supervised in Brazil at an English language teaching graduate program and also at an interdisciplinary postgraduate program in Languages, Media and Arts.

Grounding the Discussion: Literature and Methodology Overview

As a leading name in pedagogy, Freire's (2005) ideas concerning language teaching and learning as an act of politics and power, with high stake social consequences, have inspired a great number of studies and the birth of several other similar educational theories. Luke and Dooley (2011, p. 1) propose, as per Freire's discussions, that literacy practices should promote emancipated citizens and social equity. Presently operating within the context of a digital technology-centered society, concepts of literacy are re-signified, as the print text has been gradually losing space to redesigned reading and writing practices that involve hyperlinked, multimodal and inter-semiotic texts (Lankshear & Knoble, 2011). It is important to ponder what kind of influence these recent developments have on language teachers' work because "the bearing of technology on the role of the teacher has been one of the most contested areas of educational technology discussion" (Selwyn, 2011, p. 117). Following ICT development, several different educational approaches have been espoused, some of them sporting apocalyptic points of view. For instance, it has been questioned whether schools might become redundant, facing the way online media resources allow information and knowledge to be produced, shared and accessed (Lemke, 1998).

Whichever approach we take, it is reasonable to say that educational issues are a complex subject, and that it involves a lot more than simply selecting and using a set of tools and techniques, no matter how "cool", updated or resourceful they might be (Selwyn, 2014). As Lankshear and Knobel (2008) suggest, new technological affordances would (hopefully) provide us with rather diversified teaching opportunities. However, just moving our lessons from print texts and black/whiteboards to online content displayed on digital screens does not cater for a new *ethos*, as Lankshear and Knobel (2008) propose it. According to those authors, in order to establish a new *ethos* in educational settings, educators would have to combine a set of new techniques with renovated (or even new) practices, thus stimulating a *new mindset*. Taking digital technologies for granted, as if they would autonomously be capable of achieving the desired changes so as to transform education and social realities alone, might sound dangerous, if not a bit naïve. Consequently, when dealing with the dilemma of intersecting education, technology and a critical view of literacies, two important aspects need to be taken into consideration: firstly (though not necessarily *at first*), we need to be aware of the assumed impacts of technology on pre-service / in-service teachers (Selwyn, 2011). Moreover, there is also relevance in re-discussing the intended purposes and objectives of education itself (cf.: Selwyn, 2011; 2014; Luke & Dooley, 2011).

Assumed (and Assuming) Impacts of ICT on Teachers

Unfortunately, and in a rather common fashion, a set of assumptions concerning people's expectations towards the impact of any *new* technology on teachers/teaching practices might usually drive to misconceived notions of the role of education and educators. The relationship between any new accessible tools and their effective use in a classroom is not one of immediate cause and consequence (Selwyn 2011; 2014). Assuming that radical changes in education and their consequently social effects will be achieved by merely implementing or using new technological equipment might be a formula for disappointment. On the same wavelength, there have been other identifiable assumed outcomes, such as expecting that teachers would, automatically and immediately, be willing to take part in a variety of social networking media platforms identified as "ideal means for 'a large and diverse community of education professionals' to share their knowledge, experience and good practice with others around the world" (Selwyn 2014, pp. 118-119). Assigning blame to teachers for not using digital resources at their best would just mean we are supporting a partially-cut historical view of the issues at hand. It would also expose us to the dangers of transferring moral imperatives onto educators and educational institutions as a form of claiming for practice and process renovations solemnly based on the (supposed) beneficial outcomes of bringing digital technology affordances to schools (Selwyn, 2014).

Intended Purposes of (Language) Education

Considering my own professional scenario, I propose the discussion of educational purposes in the area of language education, more specifically, English as a Foreign Language (EFL) education, as well as in the context of the interdisciplinary postgraduate program in Language, Media and Arts. In accordance with critically oriented perspectives, I have assumed that one of the main objectives of education is to promote citizenship and, as a consequence, foster social equity. For a language educator, this means approaching texts, their correspondent codes and discourse(s) as "human technologies for representing and reshaping possible worlds" (Luke & Dooley, 2011, p. 1). For instance, adopting critical literacies as their pedagogical approach, EFL educators would plan their lessons in order to promote learners' discursive engagement and critical analysis capacity, thus favoring socially situated practices (Lankshear & Knobel 2008; 2011). In terms of associating ICT with EFL educational practices, it would mean rethinking practices as well as techniques in order to pursue the "new ethos" (Lankshear & Knobel, 2008), i.e., favor a set of new techniques/tools that are currently actually used to create new socially-shared practices, the ones that somehow represent effective changes in not only *what* is done, but also *how, why and by whom* such things are done in their specific social contexts. As an example, we can think of social media networking platforms for video channels as resources which support affordances that allow for different people, from different social realities, to share independent, free, hybrid, remixed videos they produce and share on their own. In this reimagined environment, a fan could, for example, share and/or access a video featuring their favorite band, tv show or streaming series. Even if pre-internet fans were already familiar with remixing (e.g. fanart made by cutting and pasting magazine photos), a video channel such as the one roughly described offers a renewed fan practice which has only become possible due to digital technologies and the Internet, thus paving the way for a *new ethos*. However, as I propose in the next part of this paper, simply presenting such videos in an EFL lesson as a source for language input would not exactly represent a renewed pedagogical practice. As a matter of fact, in order to approach such *new ethos* at educational settings from a critical literacy perspective, educators would have to go beyond assisting and encouraging learners to use them. Assuming that being "literate" is a concept that embodies being competent to engage in different socially constructed ways of establishing communication means that we must recognize that institutionalized discourses and cultural practices are part of the rules that impact the uses of, as well as grant access to, those social practices – and we have to add new or developing technologies to this combo (Kellner & Share, 2007).

Methodological Grounds

A wide range of qualitative research investigating teacher activity has been conducted in the last 30 years. Lankshear and Knobel (2004, p. 4) affirm that, in a self-reflecting fashion, teacher researchers are usually teachers themselves, investigating their own and/or their peers' practices. Teacher investigation goals are often described as pursuant to "enhancing teachers' sense of professional role and identity", as well as a result of following the idea that "engaging in teacher research can contribute to better quality teaching and learning in classrooms" (Lankshear & Knobel, 2004, p. 4). Moreover, teacher research might be also seen as a means to provide teachers with opportunities to voice their claims, fight for justice, respect and social recognition and, finally, to support well-informed decisions (Lankshear & Knobel, 2004).

Given that the main goal of this paper is to debate the interface between ICT and educational practices in tertiary teacher educational contexts (in graduate and postgraduate degree programs), and from a supervisor's point of view, I have assumed a qualitative approach to teacher investigation. Exploring possible benefits of hindsight, I chose to focus on (some of) my own recent professional experiences as a professor and supervisor at a Brazilian university. In order to accomplish my main purpose, I adopted a narrative inquiry as a methodological approach to zooming in on my practical knowledge (cf., Connelly, Clandinin, & He, 1997).

It is important to notice that in this paper, I do not intend to offer any kind of rounded-up or "clear and cut" answers to the issues I raise. I am fully aware that it is a quite vast, complex and multilayered problem-based investigation topic, one that would need to be lengthy, deep and wide ranging, handled by tightly looking into each single educational context. Consequently, stated simply, this is a discussion sampler. The experiences I present focus on the actions I have personally taken in order to foster a critical approach to digital technology use, mostly by dialoguing with my students during supervising hours. These are the moments when I make well-informed efforts to provoke them to rethink their own views on the use of ICT in education from a critically oriented perspective. Something I genuinely believe might have somehow impacted their education. Thus, what I do intend to achieve with this paper is to instigate further debates on the raised topic by offering my own *practical knowledge*. Connelly et al. (1997, p. 666) explains that “teacher practical knowledge” is a term coined to conceptualize the idea that teachers are “knowledgeable”, and that they draw this knowledge from the “sum total of the teacher’s experience”. One of the methods to collect such practical knowledge is by autobiographical writing, a narrative activity in which “people write about their histories, their hopes, their ambitions and their personal and professional stories” (Connelly et al., 1997, p. 667). Accordingly, McAlpine (2016, p. 32) states that narrative research is a useful qualitative methodology that should be considered as a “broad landscape” either in collecting and analyzing and/or reporting results. Integrating social context and temporality, and denoting agency to the narrator, narratives are a constituting part of our daily routines. McAlpine (2016, p. 33) informs us that stories are practical ways for a person to build up a plot where their lives are narrated within a coherent sequence, integrating past, present and future, because “each account, whether told only to oneself or to others, provides a robust way of (…) locating oneself and others in the account, and foreshadowing the future.”

Hence, by adopting narrative research as a methodology, I am also assuming an interpretative approach, one of many remarkable methods used in qualitative social sciences inquiries. I also assume this perspective because, as several other researchers involved in language and discourse investigations, I reckon that stories are basic units of human experiences (McAlpine, 2016), and so it is an important tool to perform a reflective study based on my experiences at tertiary education. Therefore, the next part of this paper brings an *excerpt* of my *practical knowledge*, in the form of an autobiographic narrative, a sampler meant to illustrate this discussion. It reports (some of) my empirical efforts, as a supervisor, to deal with the implications of assuming a critically oriented approach to ICT in education, hoping to provide other tertiary educators with insightful ideas.

An Autobiographic Narrative Sample of Practical Knowledge

Having adopted a critical approach to education in my own working practices, I have faced considerable and varied challenges whilst helping graduate / postgraduate candidates to try and assume a critically oriented view of their own work. During supervising sessions, when my students and I sit down to discuss possible pedagogical uses of ICT in EFL teaching/learning processes, or when we are weighing the role of digital technologies in their research interests in the postgraduate program, I often face resistance and, sometimes, confrontation. The idea of problematizing established uses of either any sort of technology (new or old) or socially conformed practices is a daring one that not many are willing to partake in. Having worked as a teacher for over thirty years, I have dared myself to confront my own former established perceptions of teaching and learning, ones I had carefully crafted throughout my teaching career. The first time I had effectively faced this challenge was during my doctoral research years, when I carried out a dialogically oriented Participatory Action Research, in a Brazilian public school, to investigate discourses about digital technology in EFL lessons (Azzari, 2017). Working with a volunteer in-service teacher, I embarked on a journey that would take me much deeper and further than I could have ever expected to go. Being confronted by my former supervisor (already a critical literacy practitioner) in the very first days of my Ph.D. research, I felt the effects of operating under these critical perspectives. I usually say that I started that journey with a lot of certainties, a couple of questions and an “all high and mighty” attitude, just to finish it with a lot of different question, a set of broken paradigms and the strong feeling that I still had a long way to go as a researcher, and for an unforeseeable future. But as poetic as it may sound now, it surely was no bed of roses, a fact well registered and documented in my published thesis (Azzari, 2017). All in all, my point is: critical thinking, at first, hurts.

Most Brazilians in their forties or fifties are products of military dictatorship-oriented schools, guided by an industrial-like ethos. We were trained to show respect to the teachers and institutions, bearing a sort of “distant appreciation” for what they would represent, not for what they really were. As learners, we were not taught to critically think, question or look at others or ourselves. Then, one fine day, we grew up and became teachers. We started our careers using black boards, chalk, and print textbooks. All the information we needed to know and teach was carefully gathered in expensive, heavy print encyclopedias and our roles and identity as educators were clearly cut and handed out to us, even after the winds of democracy came, putting down the barriers of those dictatorship years. All of a sudden, the nineties came up with revolutions in the form of personal computers, mobile phones and whiteboards. Then, the years of 2000 took us up and down on an information and communication rollercoaster. Schooling would never be the same, would it? I used to think, as many alike, that the problem of facing little to no change in current schooling might have been the fact that we had not changed the way we organize our classrooms, many of which are still decorated with heavy desks, carefully lined up one in front of the other, or maybe because the teachers were merely scanning their old overhead projector-laminated exercises to make them look brand new in a power point presentation. However, critically oriented perspectives of literacies have made me see that the changes in educational issues run much deeper than that.

When one of my students, in their late teens or early twenties, come to supervising meetings and tell me he/she wants to write a paper on the uses of free video channels, available on Internet, to simply show “how great” digital technologies can be in a contemporary EFL lesson, I have to blink twice in order to see if I am not still trapped in the eighties. Then, I usually throw them back by asking a question such as “And how different would that be from playing a video snippet from a videocassette recorder tape?” At first, it seems they take it as a rhetorical question, to which I usually only get a bemused face and a shoulder shrug for an answer (I wonder if the matter is that some of them do not acknowledge VCR technology). It actually happened last year and, unfortunately, more than once: one student wanted to design a project about using modern cartoons (*all digitally available, of course*); the other wanted to propose the use of video lessons with grammar explanations (*from a free social media video channel, of course*), and the other wanted to use a very famous, very behaviorist and structuralist-oriented platform (*digitally situated and free, of course*). According to those students, all of the resources mentioned were meant to “help promote the use of ICT in EFL lessons”. And that is when I interfere as a critically oriented supervisor by asking them questions such as: *What for? Why? How? How different would that be from other ingrained practices*? And, for the *pièce de résistance*, I challenge them to look into the discursive dimensions of their selected digital objects in order to develop an educational/research project in which the use of ICT is underpinned by a critical literacy rationale.

After the initial shock (which sometimes never seems to be surpassed) and even after some of them confess that they had actually imagined a “much simpler research project”, the majority of them end up accepting the challenges I propose. As a matter of fact, these (now) teachers, who once were under my supervision in higher education programs, have managed to come up with some meaningful, feasible and pretty good ideas that not only did integrate the use of new technologies, but that also reflected a *new mindset* (Lanskhear & Knobel, 2008). Due to the innate restraints of this present text, I am now unable to fully describe those projects but, roughly speaking, most of them still integrated digital videos, inverted lesson-like activities, podcasts, the use of several social media platforms, and others alike, otherwise critically approaching those resources and suggesting situated and meaningful practices. Bearing EFL lessons at regular schools in mind, some projects have dealt with new literary text genres, such as *Instapoems* (short multimodal poems written/circulated on social media platforms). Others have worked with literary classics, as the likes of Shakespeare’s dramas and Oscar Wilde’s novels, suggesting that digitally adapted versions of those stories (re-signified as chats, instant messages or even as comic books edited by a famous superhero publishing company) might help teachers to fill the gaps between young learners and such linguistically/discursively complex texts. All in all, those projects have gone beyond a “language-as-a-code” and/or a “techno-enhanced” simplistic perspective to explore new paradigms such as:

- What their future/present EFL learners could learn from those ICT objects and their semiotic affordances;
- What other literacies might as well be developed with such objects (such as EFL students producing their own videos, joining discussing forums, using online platforms for creative and collaborative writing, etc.). These latter items are ways through which the uses of ICT in education might privilege

students' actions (apart from adding variety to teachers' procedures and materials), which implies providing learners with access to some of the technologies and the digital literacies they also need to engage in out-of-school socially shared practices.

Last, but not least, the graduate/postgraduate learners would go further and include critically oriented discussions in their EFL projects, also preparing activities that involve the use of ICT to problematize institutionalized discourses. Some questions that have popped-up in their activities would be: *"How does that movie represent diversity?"; "What female / disabled people images are portrayed in the video (or song, videogame, RPG game, forum comments)?"; "What does it represent?"; "How does it portray relationships/ different cultures and what does it mean / imply?"; "What does a family look like in your community and how does it compare to the texts you have just worked with?*". These sample critically-oriented discussions would be part of the ICT enhanced activities and would be stated accordingly, depending on each particular semantic content/main theme at hand.

Reflecting upon this roughly noted excerpt of my practical knowledge, I see that initial ideas of the use of ICT in EFL education turned into well-informed proposals once those novice teachers were faced with my conscious decision to foster critically-oriented uses of digital technologies. Therefore, I hope that this might be considered as a starting point for the discussion I aimed to generate.

Final Comments

As a consequence of the scenario presented in the introduction, it has been commonly assumed that any contemporary class should regularly include some form of technological enhanced practice. Although it might sound as a fairly recurrent social movement in educational history, I suggest that an urge for implementing and/or exchanging sets of tools and procedures in educational settings solemnly based on current ICT technology availabilities still needs to be taken by academic researchers with, maybe, more than "just a pinch of salt". For a geopolitically and economically heterogeneous and contradictory country such as Brazil, for instance, that is currently living under the premises of far-right conservative policies, and where there is still such a long way to be paved in order to find (some) sort of social equity, the interface between ICT and educational changes still demands a lot of critical thinking. This also implies rethinking the *roles performed by* tertiary educators in promoting the use of ICT in education, as well as *how and why* it is done. All in all, reflecting upon my *practical knowledge* as a tertiary educator (cf. Connelly et al., 1997), I conclude that my own role in fostering critical literacies might never be a comfortable one at first, as no real change usually is, because promoting citizenship and social equity has to do with confrontation and dissent. It means that sometimes we need to ask disturbing questions and it certainly involves making a serious effort to find breaches and scape-routes, new *mindsets* and *ethos* in education, in order to disestablish old social orders and construct new ones. Maybe, the act of renewing equipment and procedures, thus giving teachers and learners access to digital resources, should be taken as a possibility to provide those actors with opportunities to develop new *practices* with new *techniques*, a *new social mindset*. It means the ICT use in education would be also promoting other multiple and equally important literacies, currently needed in order to enable social participation and for real citizenship to flourish. Hopefully, we can still make it feasible to reimagine possible futures, when social equity and justice is achieved through education.

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DIGITAL SELF DEFENCE – TOWARD A HUMANIST CIVIC CYBER-SECURITY SYLLABUS

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Abstract

The pressing necessity and significant challenges for a course in '*Digital Self Defence'* are explored in this paper. In light of widespread failure to usefully communicate deep technical knowledge necessary to protect citizens amidst an increasingly hostile and complex digital landscape, an alternative approach based on film, literature, psychology and game theory is developed. A description of the content and motivations for pilot lectures is offered along with commentary on successes and failures of certain methods and messages, and the course's impact on students' lives.

Introduction to Digital Self Defence

In the 1980s governments of many European countries began ambitious programmes of computer literacy. They perceived a looming crisis of innovation, and so created educational projects to prepare a generation of digital workers. As personal computing became a reality in the UK, the BBC gave us a 6502 microcomputer, books, magazines and nightly mainstream television programmes teaching BASIC programming. Teachers stressed the importance of computer science, so as 10-year-old children we all learned about RAM, ROM and how disk drives and CPUs worked. Many of us have had exciting, happy and rewarding careers in the technology industry. We have played our part in building the internet and the digital world we see today.

Forty years later a new crisis is looming. As the science fiction writers warned us, digital technology is turning from being our servant to being our master. Privacy, dignity and democracy are under sustained attack. The problem is not the technology *per se*, but the ends to which companies and governments have turned it. My generation heard from our grandparents how democracy was snatched back from the jaws of fascism in two world wars, at enormous cost. But in our enthusiasm as technologists we have been well meaning, unwitting accomplices to the reprise of enslavement. As for many computer scientists, my world changed in 2013 with the revelations of Edward Snowden. I put my life work in digital signal processing on a back burner to start figuring out how to save computer science for my children, how to preserve a world of digital technology compatible with intellectual enquiry, freedom and democracy.

Unlike the 1980's there is no grand social project backed by government and media. Since 2015, I have been developing a "civil and personal cyber-security" curriculum. Academically it would be described as a "philosophy of human values and technology”. Practically, the aim is to teach data hygiene, info scepticism, personal operational security and intellectual self-defence to students who do not have technical and mathematical pre-requisites. The hope is to educate a generation about their ownership and responsibility to steward technology. I see this as distinct from “digital literacy” which, for the most part, I feel is a project to teach people to accept and utilise established paradigms rather than continue to challenge them creatively. The first course ran for eight weeks in 2016 at SAE Institute London, generating extremely positive feedback, and was described as “life changing” by students. With encouragement from colleagues at Solent University, Southampton, I have polished and re-branded the lecture series as *Digital Self Defence*.

Enhanced Security Thinking

Our metaphor of martial arts works extraordinarily well on a number of levels. A real martial artist never goes out looking for fights, but cultivates inner security, self-discipline, mindful awareness and respect for others and the environment. We have explored running the classes as part of a women's self-defence series embedded within a programme of Kempo and street situational awareness to complement physical safety with an intellectual self-defence against cyber-bullying, stalking, tracking and surveillance. There are currently plans to deliver an updated version of the course at the University of Edinburgh and at the University of Central Sweden in 2019. An important goal is to resituate "security" as an idea, through a philosophically broader and deeper treatment than established accounts of the subject. We unpack and challenge ideas like “nothing to fear, nothing to hide”, “freedom and security are a tradeoff” and apply quite rigorous philosophical analysis to the tension within security with regards to individual and collective good.

What do I mean by a “Humanist” approach? Much modern security thinking revolves around the objects of machines and systems, protocols, timing, utility, value and suchlike. As a lifelong student of Humanist philosophy, it strikes me that what’s missing from this picture is the subject. I am of an anachronous mindset, an old Jedi sect who believe that computer science should be about Intelligence Amplification (IA as opposed to AI). It should enhance all areas of human experience, including arts, entertainment, medicine, exploration, care, social life, and the myriad other dimensions of life that are not conflict and acquisition – the Dark Side. Sadly, the origins of most cyber-security is in finance and warfare, which means that when translated into a reductionist neo-liberal civilian culture it has no connection with people (*qua* humans) except as “consumers” or “targets”. A Humanist approach brings cyber-psychology and cyber-philosophy right to the heart of the project in an attempt to restructure attitudes and dispel those assumptions.

Why the branding of “Digital Self Defence”? Initial feedback from the students revealed that “cyber” and “security” are words they associate with unpleasant practices and things which are against their interests. Philosophically and psychologically *security* has many meanings. Those proffered by John Bowlby (Bowlby, 1988) and Eve Ensler (Ensler, 2006) are among the more interesting interpretations we explore. A notable modern thinker with broad and intelligent interpretations of security is Bruce Schneier (Schneier, 2008), a proponent of "technology in the public interest". We pay some attention to the position of American software freedom pioneers Richard Stallman (Stallman, 1997) and Eric S. Raymond (Raymond, 2001), who remind us that computer security is immanently expansive, and must be absolutely open to scrutiny. Accessible, well written core texts such as Ross Anderson's *Security Engineering* (Anderson, 2008) create a broad foundation. To this mix we also bring elements of communication theory from thinkers as diverse as Claude Shannon and Herbert Marcuse, along with game theoretical, cybernetic, systems and modelling ideas from thinkers as different as Norbert Weiner, Dana Meadows, John Nash, Andrey Markov, Vilfredo Pareto, and Robert Axelrod, touching on subjects like equilibria, threat, percolation, diffusion, contagion, tipping points, and coordination problems.

A good question to open our discussion is "Security for who, from what, and to what ends?", because there is no meaningful *noun* sense of security. Security is not an '*add on*' product to buy, or a thing one can make and then sit on. We look at the idea of "toxic security", which comes from an "industry of security" which is never satiated, where profit derives from a perpetual situation of insecurity. With a disturbing likeness to Munchhausen syndrome by proxy, or factitious disorder, where "keeping the patient sick" is the goal, such thinking creates an ever-growing sphere of imagined new threats, and "solutions" that beget ever more problems. A salient formulation of this concludes Adam Curtis's acclaimed documentary *The Power of Nightmares* (Curtis, 2004). Clinical psychology and psychodynamics figure in this analysis, including the role of personality in security thinking.

The over-reach and failure of state security "collect it all" programmes is examined, as expansive financial black holes from which no light of metrics, impact or success can ever escape, devouring billions of public money while small businesses and individuals go, at best unprotected, and increasingly weakened by misguided state projects. We also analyse the recent swerve towards "offensive security" models, as championed by US military cyber-command. Under the maxim that "attack is the best form of defence", this credo promotes the active manufacture and distribution of new threats, engaging in pre-emptive hacking and the production of malware. On face value the objective is: *continuous offensive penetration and presence inside computers of the enemy*, to have "total information awareness" (TIA). Again, a psychological and historical context is used, with comparisons to 11th and 12th century witch hunts, inquisitions and US McCarthyism. This helps us to understand how a relatively small clique can dominate a society's security narrative.

Understanding threats, probability and motivations is another key area. Notional enemies that are "everywhere, everything and everyone" appear to be misguided and counterproductive. Models of trust and dependency are needed to approach the subject of 'Big Data Tech' and the ongoing abuses of companies like Google and Facebook before we can explore alternatives and strategies for disengagement. An historical context is useful too. The rise and fall of the Kempeitai, NKVD, Stasi, KGB, Gestapo SS, help us see limits of security, and to understand the decline of societies where security dominates every aspect of human existence, where it strangles economies, creativity, trade, art and education, and eventually the political and military leaders who imagine themselves its masters (the lesson of Stalinism). Because there is no possibility of a healthy balance with that kind of security, mature security thinking must seek to identify and minimise it. Long term security involves defence against certain other kinds of "security thinking". To this end we follow Dana Meadow's wisdom (Meadows, 1997), to intervene in systematic values of security, to strive for a minimal security framework which is a maximiser of freedom and democracy rather than a threat to it.

Existing Projects

Many programmes exist with the aim of creating future cyber-security professionals. For example;

- In the USA, the DHS National Initiative for Cybersecurity Careers and Studies (NICCS) "Teaching Kids the Importance of Cybersecurity Through Games" (U.S. Department of Homeland Security, 2013). See also: "Hacker High" (Woerner, 2016)
- University of Tulsa: "Building Cybersecurity Capacity via Sustained Teacher Training" (2018, (Tulsa Regional STEM Alliance, 2016).
- In the UK, as reported by the BBC (Symonds, 2017), The Department for Culture, Media and Sport have recommended cyber-security lessons offered to schools in England. A 2014 press release reported "School children as young as 11 to get cyber security lessons" (Gov.UK, 2014) according to a government programme named "*The Cyber Security Skills: Business Perspectives and Government's Next Steps*".
- Privately, many youth-clubs, schools, YMCA and PTA groups have taken initiatives to educate parents.
- Vodafone made a foray into corporate responsibility producing the *Vodafone Parents' Guide* (Vodafone, 2009), attempting to tackle subjects like cyber-bullying, fake-news, screen time limits, over-sharing, sexting and body-image issues.
- Universities offering Bachelor's and Master's degrees in cyber-security are becoming more common. In the UK, Cambridge, UCL, Kent, Derby, City, Birmingham, Southampton, Solent and Northumbria have some courses, while in the USA I have counted over 30 state and city universities offering courses.

Why We Need a New Approach

Teaching the value of data hygiene, anonymity, cryptography, device and code authenticity, offline computing, information scepticism and verification craft, gives a different perspective on cyber-security as an everyday life-skill, one that can be shared amongst friends and families. However, the above programmes are intended to create a pipeline of capable cyber-defence for *industry*, based on threat models we know today. Many are network administrator courses dressed up with a bit of extra "intrusion detection" and "critical thinking" to make popular new course titles attractive to students in a competitive higher education market. Outside academia so-called "crypto-parties" (SBS, 2012) have emerged as pop-up educational projects aimed at journalists, therapists, doctors, small business owners and other professionals needing to protect themselves and their clients against surveillance and tracking. These tend to self-filter audiences to already well-educated persons with civic awareness. Programmes for parents, while commendable, are symptomatic relief, treating problems as if they were inevitable facts of nature rather than encouraging the kind of critical thinking in children that would arm them to change their digital world rather than meekly adapt to, or avoid it.

As top percentile hackers will attest, it's doubtful whether critical thinking about computer security can usefully be taught to adults anyway, it's really a mindset thing, one that begins when you are about 10 years old. Keeping pace with changing threats requires an endowment for anticipating them, not reading about them in books. More to the point, these kinds of courses are not generally aimed at a personal understanding or providing intellectual self-defence against manipulation and the negative social aspects of digital technology. They do not address inherent risks in some kinds of technologies or technologically mediated relationships. They contain little or nothing in the way of ethics or civics, although many courses deceptively misuse the title "*Ethical Hacking*" (by which they conflate ethics with parochial legality).

Issues of technological self-determination and freedom are becoming entangled with those of "cyber security" in an unhelpful way. Old ideas, rooted in property and criminal justice, perpetuate an increasingly unhelpful view that everything will be fine if we can just rid ourselves of the "bad stuff", iron out the bugs in some software and catch a few rogue cyber-criminals. Within the frame of classic cyber-security, perimeters, attribution, ownership and motive are all too blurred now to see clearly. Who the "bad guys" are is no longer clear, and we can no longer trust those who might tell us. The *raw technique* of cyber-security is no longer enough in the context of a moral free-for-all. Young people are ill equipped to deal with "fake news", tracking, doxing, intimidation, and extortion. They do not trust their devices or institutions, and these institutions and manufacturers are not the right people to be advising them. Further harm accrues with the rapid onset of Internet Balkanisation, disintegration of trust in systems, states and manufacturers which have all been unfolding since Snowden's revelations.

For my own generation, and back as far as my great-grandparents who fought in the Great War (1914-18), sceptical enquiry was the mark of an adult with worldly common sense. Today's technological culture infuses a palpably anti-intellectual and infantilising tone, where young people are inhibited from rational enquiry and from expressing their deeper needs or opinions. They are talked down to by "experts" and discouraged from exploration by those who gain from their stasis. For example, the Vodafone guide mentioned above is a mish-mash crafted by dozens of high-profile contributors associated with

Google, Facebook, Amazon, Apple (all predatory online marketers from whom we should be protecting young people). It seems to weave together every cliché about “digital natives”, “Generation Y” and how adults are “in awe” of kids using technology. It is pushing candy while wagging a finger about bad teeth and getting fat. It is, frankly, naive tokenism of the *status quo,* which comedian and playwright Stewart Lee (Lee, 2019) mocks as “Mr. Fox's guide to chicken security”. What should be worrying for those of us passionate about the potential for ICT in education is that technology *qua* hardware and software is inseparable from the culture and politics that envelope it, so unless current trends are arrested these wonderful tools of potential empowerment will surely become shackles of mind-control. In this sense we interpret security as ‘*security from...*’. Security from control and malinfluence is absolutely aligned with all senses of *freedom*.

For most of us though, encounters with “security” are overwhelmingly negative. As Ensler writes in *Insecure at Last* (Ensler, 2006), it's “authentic insecurity” that's missing today. The kind that builds awareness and real strength. The paradox here is that real security is like exercising for health - someone else cannot do it for you. The more dependent one becomes on outsourcing responsibility, the weaker one grows. Schools and even universities now spy on their students ostensibly to monitor bullying, alcohol, gangs, underage sex and terrorism. While this seems justified to a minority crippled by fear, the reality is that we are naively pouring fuel onto a bonfire of trust, undermining earned maturity and genuine social awareness - ultimately the most important things that formative education can offer.

Obviously, schools and universities, even in legal *loco-parentis,* have no legitimate role as quasi-police. In the US and UK tragically misguided government regulation aligns with corporate profit motives to put armed cops in classrooms, metal detectors, barbed wire and CCTV at school gates. We inflict upon our young people a culture of over-monitoring, highly corrosive to learning relationships. RFID badges track student location, building intricate behavioural profiles. Parents in the UK are fined if they take their stressed kids for a day at the beach, as relief from relentless standardised test drills. Childhood depression and university student suicides grow each year. Schools, embracing the worst technological indulgences of Bentham's micro-managerial control (see Brunon-Ernst, 2012 for a modern account) are little more than prisons, and the solution for children with higher human aspirations, who do not fit into the machine, is to medicate them.

We are raising a generation who will be turned easily against occidental liberal culture, towards a deflated, one-dimensional conceit of ‘progress’. For example; the anti-vaccine movement highlights a growing neo-Luddite trend amongst the young, middle-class, and well educated. It is not as the press might have us believe “uneducated idiots” leading this catastrophe, but those intelligent enough to rightly suspect their trust in institutionalised technology is being abused. Those who doubt the sincerity of institutional care find a lucrative market for “alternative science” exists to comfort them. Attacking the pushers of junk science is picking the wrong target. Plenty more peddlers of alternative facts will spring up in their place to meet demand. Security in this sense is about rebuilding trust, not imposing truths.

This kind of reaction is one which we are starting to see in digital technology. Educational information about complex balances of threats and benefits, at an individual citizen level, must be re-aligned with liberal interests, by treating citizens as adults. It must not be deceptive. It must not be unverifiable in principle (such as hiding behind secrecy). Failure to achieve this basic quality standard is a collective societal suicide. Since Edward Bernays (Bernays, 1928) misused psychoanalytic theory for advertising, and governments in the 1950's and 60's embarked on Cold-War mass mind control projects, systematic deception became an expected norm. Systematically distorted communication is part of everyday life now, while real science and reasoned discourse, which has always been a marginal exception rather than the rule, is increasingly on the back foot. The disingenuity of politicians and intelligence agencies who sow discord and confusion to serve their parochial interests now constitutes an additional *real* threat to existing *actual* security problems. These actors are unlikely to take the moral high ground any time soon.

As teachers and parents, we disappoint our young men and women by failing to stand up to, and set a good example in contrast to, predatory corporations and misguided governments. This also threatens our economic future. My experience of talking to young people in universities indicates they have no desire to grow up to work for government or for the likes of Google, Facebook, the NSA or GCHQ (and if people in those places don't know that, they should urgently spend time talking to their kids). This is a tragedy on many levels, because while civic and commercial structures need fresh blood a huge recruiting crisis is emerging. Thus the advantages of scale, and the positive, even necessary aspects of big-tech and state apparatus, are subverted and sabotaged by the likes of James Clapper lying under oath (Fung, 2014) about the misdeeds of the NSA, and Mark Zuckerberg showing sneering disrespect by calling his Facebook users "Dumb fucks" (Tate, 2010). In this sense, another security problem is *contempt.* It's a problem because most real security solutions are long-term compromises between competing interests, and there can be no compromise so long as there is a lack of *good faith* arising from arrogance. In the 20th Century, the Northern Irish, Arab-Israeli and many other conflicts should have taught us that superior strength or even outright victory are insufficient to win security.

Another obvious disconnect concerns the role of women in tech, which has received significant press lately. We pretend to wonder why there are few women in tech, proffering silly theories about the workings of women's brains for engineering, or bemoaning the patriarchal structures that discourage women. But if, as a large body of research indicates, it's true that women have increased emotional attunement to negative behaviours, then their representation may have an entirely different explanation… namely that much of "tech" these days is a circus of thinly veiled abuses dressed up as business. It's not that tech doesn't interest women they just feel they can do better than that in life. What if it's our Western "enlightenment" narrative about the liberation and empowerment of technology that is wearing thin? Are women looking at the most visible *ends* of digital technology, seeing systems of control and domination, and looking for other paths in life? If so, we need them in technology more than ever.

What future is there for industries that are increasingly predicated upon deceiving and spying on each other? I believe they will be exclusively staffed by over-40s before long. A substantial reactionary disconnect from technology by young people is looming. It's no secret that Silicon Valley tech leaders keep their own children far away from mainstream online social media, and that "the next cool thing" for young people will be going "no tech". Will we support them in that? Will we stand behind our teenagers when *they* decide that carrying a smartphone is something only for "silly old people whose brains stopped working"? If we want to preserve the advantages of a technologically enabled society then we have a generation that needs urgent help re-imagining technological relationships and building free, open, distributed alternatives for every kind of digital technology. We need to keep them on board with computer science as a progressive rather than oppressive project.

Finally, there is the most frightening prospect that as we are losing control of digital technology corporations and governments are experimenting with AI in ever more adventurous ways. That is not to say that AI cannot serve humanity with immense benefits, but in all likelihood, it will amplify our existing problems first, and we will not survive that. Humans must face the fact that we will have to fight machines at some point. Most thinkers consider that an unwinnable battle, in the same effective category as nuclear war.

Fools who think they can infallibly control the machines, and so act recklessly, must be considered themselves as a new class of threat toward which Humanists should direct a counter-social-engineering effort to challenge foolish utopian ideologies. If history has taught us anything, it is that when we hear the word "safeguards" from corporations or governments it is time to *really* worry. Safeguards are only ever sticking plasters applied to give a token veneer of action after it is already way too late. We know that neither the capital projects of corporations nor the social aims of governments are sufficient to steer the course ahead of us, not without a third arm of powerful civic mobilisation rooted in early education. If we can give people the ability and will to understand and control technology, and, if necessary, turn it off until it is (or we are) ready, the future may be very much brighter.

Challenges and Funding

A difficulty in getting support for a project of civic cyber-security is presumably that governments, corporations and other potential funding sources are ambivalent about it. They rely on weakness for their own ends. Official cyber-security projects are designed to maintain the corporate status-quo. For freedom and democracy, the issue is that these institutions are part of the problem. Cyber-security *from* the corporate surveillance state is needed as well as cyber-security *for it*. An obvious conflict of interest exists, and it seems reasonable to suspect that while vigilant elements of government do acknowledge cyber-security as a national interest, neither government nor industry in general really want it widely taught. Or rather; a hopelessly limited interpretation of it is begrudgingly supported.

There is a fledgling movement around “Technology in the Public Interest” (Schneier, 2019; Slaughter, Walker, & Kramer, 2019) which is promising, because it offers a banner for a swelling group of deeply concerned scientists and developers who have until now been marginalised and even ridiculed. However, it remains to be seen whether any centre of this association, which is ostensibly funded by the Ford Foundation, can hold loyal to “the public” once the required opposition to entrenched power becomes clear and urgent to those involved. So long as powerful individuals believe strong civic culture of technologically informed citizens would subtract from their power, the only entities worthy of defence will remain giant businesses, not citizens.

Whereas the UK created a very promising looking new agency as an adjunct to GCHQ, the NCSC disappointingly turns out to involve an alliance with a questionable (Salcito, 2019) US defence corporation, Northrop Grumman. Although several people have suggested we obtain funding from them, there seems little hope that would work out well given the Northrop Grumman's record, so we must presently look elsewhere for assistance with the project. In 2018 I wrote a research proposal trying to cement links between British Army 77 brigade, where I had a reliable colleague, and Solent University. The idea was that since education and positive influence campaigns can fall quite nicely under the remit of "positive psychological operations", we might be able get a grant for research on a set of powerful taglines, slogans and accessible maxims - all aimed at raising awareness of collective cyber-security obligations and rights. Unfortunately, Solent University rejected the proposal as "too complex to understand", so we were unable to progress.

Philosophy and Methodology

Cybersecurity is better understood, not as a set of technical problems pitting attackers against defenders, but as a set of socio-political tensions around identity, accountability, loyalty, commonality, convenience, efficiency, sharing and much more. Within this multi-dimensional space, the positions of governments, corporations and citizens have diverged. Power asymmetries have evolved around intellectual property, the financialisation of personal data, and ownership of the means of communication and payment. The idea of digital technology as “a tide that raises all ships”, something that ultimately benefits all of humanity, must be re-examined. Schneier suggests that technology always offers a first advantage to progressive forces (Schneier, 2012), but then empowers conservative ones after a phase lag. This seems only partially correct, in that we see more than a simple question of flexibility versus inertia. There are many malevolent progressive forces that are enabled, and many positive conservative forces that do not benefit.

There is some element of zero-sum dynamics at play. Security for one group is insecurity for another. Technologies that enable one group can disable or suppress another. In light of Edward Snowden's revelations of ubiquitous illegal mass surveillance, the Cambridge Analytica scandal, and Trump and Brexit elections, we've entered an era where the internet's benefits are leveraged by well-resourced minorities against the remainder. Familiar tools we use daily are now identified as a threat to democratic life, and even to individual mental health. An impending implosion of social media is overdue as polarisation and partisan censorship grows. There are no credible authorities to turn to. Those vying for moral high-ground are all visibly, often unashamedly, hypocritical. With national firewalls, walled gardens, blacklists, kill-lists, purges, payment blockades and takedowns, the internet has never seemed more divided into hostile fragments.

The early internet was based on egalitarian assumptions, which were never explicitly examined. So, they were never truly valued. How do we now recover what is in all of humankind's interest? The necessary insights and answers cannot be obtained by technical analysis. I have tried and failed to reach more than a few percent of already technically literate high IQ students through treatments of cryptography, graphs and routing, protocols, exploits, game theory and trust models - and I immodestly consider myself a versatile and capable teacher. Somehow computer science became “everybody's problem” but rather few of us are adept at grasping computer science.

Reflection upon course feedback from the first Digital Self Defence classes indicated which bits of the lectures were reaching students. I soon realised a complete change of tactics was needed. Just as we had to learn by analogy in 1980 that “computer memory is like a box”, the key elements of cyber-security need an approachable formulation.

New Problems, Old Solutions

So, it is through drama, poetry, literature, film, classic tales, anecdotes and metaphors that a powerful understanding of modern cyber-security concepts can be obtained. Medical analogies from infection control, immunology and contagion models are also valuable. So are concepts from biological, evolutionary and genetic science.

Our problem, and opportunity, is that real life is converging with dystopian fiction. Rather obviously, insights and answers are close to hand in the writings of Goethe, Ibsen, Mary Shelley, H.G Wells, E.M Forster, George Orwell, Kurt Vonnegut, Philip K. Dick, Ursula Le Guin, Issac Asimov, Arthur C. Clarke, Aldous Huxley and so many more. As for Machiavelli's *The Prince* (Machiavelli, 1513), the material can also be read as a warning and means of disarmament. The ‘manuals’ that opponents of freedom have used to build a dystopia also contain the knowledge to dismantle it.

Alas it seems that few people read books these days, but we do have film. Since Georges Melies 1902 screen version of Jules Verne's *A Trip to the Moon*, from *Metropolis* to *The Matrix* we've had wonderful cinematic worlds conveying important messages about technology. Thanks to Kubrik, Rodenberry, Cronenberg, Scott, Gilliam, Godard, Lynch, Zemeckis, and so many talented directors, difficult technical issues can be made beautifully clear so long as we know how to interpret and present them to students. Television gives alternative accessible forms via programmes like *The Outer Limits*, *Twilight Zone*, *Dr Who*, by screenwriters like Terry Nation. One of the freshest is Charlie Brooker's *Black Mirror* series.

By exploring archetypes of the Mad scientist, the Monster, the Overreacher, the Faustian Bargain, Medusae and Hydras, we can situate abstract digital concepts in accessible narratives. Some obvious classic choices are *Dr. Strangelove*, *Gattaca*, *Eraserhead*, *Frankenstein*, *They Live*… but marginal films and books are useful too. For example; we often start a lesson with a clip from the opening scenes of Spielberg's *Schindler's List* (Spielberg, Zaillian, & Keneally, 1993). When asked about the film most people recall a scene of horror, of Nazis shooting children. But in fact, the first scene is a careful choice by the director. It is a mundane shot of a small, innocuous table with a bottle of ink, and an official asking a line of Jews, "Name please?!".

This leads us easily into a discussion of lists, data and identity, which are powerful story themes, and then to a discussion of Edwin Black's 2001 text *IBM and the Holocaust*. This technique allows us to explore themes which cannot be approached “head-on” in their present technological context. For example; the tension between ancient mores and superficial legal tyranny in Sophocles’ representation of Antigone's dialogues with Creon is a wonderful way to show young people that such struggles have existed for millennia. It releases them from compliance and parochial fear of authority - to become technological freethinkers capable of asserting their own ideas onto their digital world.

Other-worldly stories also help to overcome the considerable psychological barrier of closed-mindedness and anti-intellectualism of western culture. Our nonchalant dismissal and urbane detachment make us quite resistant to difficult messages. When they clash with our cherished worldviews, they cause cognitive dissonance. The so-called "snowflake" mindset is an extreme form of this fragility. However, when unpalatable morsels are flavoured as ancient stories young people have more appetite. Now they see why history and literature are such dangerous subjects, because they can give clear voice to perennial complex issues otherwise dismissed as "conspiracy theories", "politically incorrect" or "too scary to think about". The strength of the cannon is that it blasts through all petty and parochial guises of fascism.

Positive Messages

The aim must not be bleak technological critique in the vein of Ellul, Postman, and McLuhan but a clear call to “take back technology”. Neither must it be an exhortation to abandon technologies or attack its proponents, lest we become disaffected Ted Kaczynski type recluses living in woodland shacks. The need for a new social contract that puts technological development in the hands of citizens is a key theme. Organisations like the Free Software Foundation

(FSF) are on the right track, but championing Free software, or ubiquitous strong encryption is not enough (it leads to its own problems). Mature new understandings of hardware and data as pollution problems have resonance with students already disgusted by environmental destruction. The idea that there is a “digital environment” which is an extension of our physical ecosystems, makes sense. So do treatments of convenience and dependency as drug-like vulnerabilities. Messages already understood by students about drugs and addiction are easily adapted once digital technologies are understood analogously. We wish to replace starry-eyed cargo-cult fawning and fetishisation of technology with measured scepticism.

Restoring our technology to serve us once again is the goal. In a wider sense, we also hope to explore general counter-influence tactics. And, without any pretence at value neutrality, to bolster liberal European values and traditional ideas of the "good life". The kind of obsequious technological deference that allowed companies like Apple and Google to become so powerful, needs burying. For Europeans, the destabilising, discordian techniques of Russia and the USA dazzle us as we try to navigate the interregnum of technological "post-truth". We are no longer experiencing Baudrillard’s *Ecstasy of Communication* (Baud, 1988), rather Owen's “Ecstasy of fumbling” (Owen, 1920). Arthur C. Clarke (Clarke, 1962) got something half right when he said; “Any sufficiently advanced technology is indistinguishable from magic”. He should have added “to sufficiently lazy minds”. Those who let themselves be governed by magicians have, historically, fared no better than those ruled by jugglers and jesters.

An interregnum is a period when many people are confused about the meanings of ideas like security, community, freedom, truth, debate, privacy, public spaces, experts, opposition, hate and news. Nobody can hope to challenge such powerful tides of history, but sensible realism is not the same as giving up on navigating a way through the storm. The currently parochial project of "cyber-security" needs reconsidering, as a much bigger game, as a grand civic, Humanist undertaking. It needs updating to include propaganda and disinformation as first-class threats. It needs modernising, to recognise certain architectural patterns of political and business logic (so called Dark Patterns) as intrinsically harmful. It requires introspection, to see how some of its own practices can be harmful and its goals dishonest. This can be achieved by massively widening the audience in a project similar to the "computer literacy" projects of the 1980s. Without a will of the people to retake charge of our digital technology it’s not only money, personal data, business secrets, computing assets and military infrastructure that are targets - but our culture itself is at risk from threats within as well as outside.

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International Conference on Information Communication Technologies in Education

Proceedings

ICICTE 2019 seeks to address the many challenges and new directions presented by technological innovations in educational settings. With the keynote speaker, plenary sessions, workshops, and forums examining the integration of technology into all facets of education, the conference provides participants with a forum for intensive interdisciplinary interaction and collegial debate. Those attending ICICTE 2019 leave with an excellent overview of current thinking and practices in applications of technology to education. Thematic streams include alternative processes, procedures, techniques and tools for creating learning environments appropriate for the twenty-first century.

Conference themes include: Pedagogy in the evolving tech environment, the architecture of learning; accessibility, the evolution of the classroom; instructional design and delivery, evaluation and assessment; strategies and tools for teaching and learning; simulations and gaming; informal, non formal and formal adult education; multi-grade education; open/Distance learning; impacts on educational institutions: effects on faculty, staff, administration, and students; curriculum and program development; teacher training; building communities of teachers/educators; cooperative learning; the internationalization of institutions and of education, political economy and educational technology: Intersections, effects on training institutions and industry; ethical considerations in the use of information technology in teaching and learning; the use of technology in education to promote democratic ideals, technology in creative arts education, ethics, human rights and access to open educational resources, the application of psychology to learning mediated by technology and Blockchain in education.

Backdrop for the cover of the Proceedings:
Detail from metal art by Marie Louise Kold