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Virtual Learning

Edited by Dragan Cvetković

VIRTUAL LEARNING

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http://dx.doi.org/10.5772/62799
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Notice

First published in Croatia, 2016 by INTECH d.o.o.
eBook (PDF) Published by IN TECH d.o.o.
Place and year of publication of eBook (PDF): Rijeka, 2019.
IntechOpen is the global imprint of IN TECH d.o.o.
Printed in Croatia

Legal deposit, Croatia: National and University Library in Zagreb

Additional hard and PDF copies can be obtained from orders@intechopen.com

Virtual Learning
Edited by Dragan Cvetkovic
p. cm.
Print ISBN 978-953-51-2824-3
Online ISBN 978-953-51-2823-6
eBook (PDF) ISBN 978-953-51-4136-5

Meet the editor

Dragan Cvetković graduated in Aeronautics from the Faculty of Mechanical Engineering, University of Belgrade, in 1988. In the Aeronautical Department, he defended his doctoral dissertation on 3 December 1997. So far he has published 61 books, scripts, and practicums about computers and computer programs, the aviation weapons, and flight mechanics. He has published a large number of scientific papers in the country and abroad as well. Since 20 March 2007 he had been working at the Singidunum University in Belgrade as an assistant professor. Since 1 October 2013 he has been working as the Dean of the Faculty of Informatics and Computing at the Singidunum University, Belgrade. On 10 March 2014 he became a full professor in the field of Informatics and Computing.

Contents

Preface

Virtual learning environment (VLE) is a set of tools necessary for teaching and learning and a set of tools designed to make learning easier for students and application of what they have learned as well, including computers and the Internet in the learning process. VLE main components include the mapping of curriculum ("breaking" of the curriculum into sections that can be processed), monitoring of users (students), online support for teachers and users, electronic communication (e-mail, discussions, chat, Web publishing), as well as Internet links to external resources curriculum. In general, VLE users are identified via the ID, as teachers or as users. The teacher and the user can see the same things, but the teacher has additional user rights to create and change the content of the program and to monitor the work of users. It should be noted that the terms virtual learning environment (VLE) and the managed learning environment (MLE) are often mixed or replaced.

The lecturer or teacher is a key element for virtual learning, just like in a real environment for learning. The success of the program depends on the ability of teachers to revive the space, to attract the attention of listeners, and to receive feedback from them. No matter what, the man is still "a major player" in this environment.

Benefits of virtual learning are reflected in profitability, saving time, the consistency of learning, global communication, flexibility, employee engagement, and "friendly" environment.

Educational institutions of higher education use VLE more often in order to achieve the following:

- Economical utilization of time of teaching staff
- Cost optimization of teaching
- A good presentation of relevant content by teachers, who may not be experts when it comes to the Web
- Providing instruction to students or trainees in a flexible way, regardless of where the student is or what the time zone is
- Providing instruction in a way which is close to today's generations, because these are the generations of the digital age
- Providing networking between different faculties, universities, or campuses
- Ensuring reuse of common materials between different courses
- Providing automatic integration of results of participants in the reports of appropriate information system (locally and beyond)

Chapters are listed in a logical order, but they could be arranged differently, depending on the point of view. The first chapter provides an overview of the popular systems for distance learning, as well as their comparison, with the aim of more efficient selection for the adequate problem solving. In the second chapter, a review of all major social and economic activities in order to improve the system of virtual learning or distance learning is given. The third chapter deals with the influence of technology in the management of educational institutions, as well as the influence of the culture of behaviors within the same. The fourth chapter provides an overview of the graphic communication, which is extremely important when it comes to communication engineering and design. The fifth chapter confirms that quality assurance remains an integral and indispensable part of the process of virtual learning, as a basic pillar of higher education. The sixth and seventh chapters are dedicated to health, mutual communication about health problems and causes, as well as the facilitation of communication between persons with certain deficiencies or certain disabilities. The eighth and ninth chapters are dedicated to massive open online courses (MOOC) and their applications in education, without age restrictions. The tenth chapter refers to the widespread use of virtual reality in industrial environments because most of the leading industrial manufacturing facilities have a strategy called "concept of the digital factory", where all aspects of manufacturing are checked on computers and in virtual environments before the very beginning of real, physical production.

I would like to express my sincere gratitude to all the authors and coauthors for their contribution. The successful completion of the book *Virtual Learning* has been the result of the cooperation of many people. I would especially like to thank the Publishing Process Manager Ms. Iva Lipović for her support during the publishing process.

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A Review of Distance Learning and Learning Management Systems

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65222

Abstract

In recent years, rapid developments in technology and the web have led to many changes in education. One of the most important changes in education is in the form of distance learning. Distance learning, which is used to define education where educators and learners are physically separated, is not a new concept; however, emerging technologies and the web allow web-based distance learning and therefore increase its popularity. As a result of these developments, many universities have started to use web-based distance learning systems to provide flexible education that is independent of time and place. In this chapter, we review all popular, widely used, and well-known learning management systems and include detailed comparison of some of these systems to allow institutions to choose the right system for their distance education activities.

Keywords: distance learning, literature review, educational research, learning management systems, Moodle

1. Introduction

Distance education, which is now also referred to as distance learning or e-learning, has existed for centuries. Although as Keegan says "the ideas surrounding the educational endeavor are somewhat similar" [1], it is not easy to find a single definition of distance education. While according to North [2], a few definitions even look to define it in terms of a single technology, according to long-distance teaching [3], others display distance education simply as a recent development of the class into a remote location [4]. However, such definitions are restrictive and fail to recognize the actual needs of distance education users. Mugridge [5] provides a better definition, describing distance education as "a form of education in which there is normally a separation between teacher and learner and thus one in which other means—the printed and written word, the telephone, computer conferencing or teleconferencing, for example—are used to bridge the physical gap".

Many educational institutions have created solutions to their increasing educational needs through the development of distance education programs. Distance education allows educational paths to be determined by educators and students, who are separated with physical distance, using technology (e.g., audio, video, data, and written text). It is a form of education in which students, teachers, and teaching materials in different geographies are brought together through communication technology [6]. Using video, audio, active learning, simulations, and electronic advances appeals to a variety of students with multiple learning styles.

This chapter presents a review of distance learning literature; the purposes, advantages, disadvantages, and types of distance learning; and a detailed comparison of web-based distance learning tools in education.

2. A review of distance learning

Research on distance education has been subject to long and numerous debates [7–10]. Distance education needs a reliable means of communication between students and lecturers. Therefore, the history of distance education begins at the point where a reliable communication method is established. Most historians date distance education to the eighteenth century, when a few lecturers began to offer what were called correspondence courses. One of the first examples of distance education was observed in 1728, when "an advertisement in the Boston Gazette named 'Caleb Phillips', teacher of the new method of Short Hand" was searching students for lessons to be sent weekly [11]. But technology-based distance education started after the introduction of some devices, which are using both sight and sound, into the schools in the early 1900s.

In the late 1960s and early 1970s, microwave technology was developed. So networking technology costs were reduced, and universities began to use microwave networks to take advantage of the Instructional Television Fixed Service (ITFS) authorized by the Federal Communications Commission [12].

Today, distance education programs have a wide range of approaches [13]. For example, independent study courses through computer networking, computer-delivered instruction, communication between students and instructors through electronic mail, class sessions, cluster groups, undergraduate and graduate degrees through cable networks, and video courses with texts and other collateral materials are these approaches [13].

In summary, the history of distance education shows a constant state of evolution. In the historical view of distance education, a stream of new ideas and technologies has been observed. Historical development of distance education shows that nontraditional education tends to blend with traditional education while meeting the changing learning theories and developing technologies [13].

2.1. The purposes of distance learning

The main goal of distance education is to overcome barriers of place and time. Learners may live in isolated, less-populated and nonurban, rural areas and have no access to education.

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Other learners may have ready access to a private school or college but that college might not offer the course of study needed by that learner. Distance learning allows education to reach those who are not able to physically attend courses in universities [14].

One of the most important purposes of distance education is to provide an opportunity of education, often on an individual basis, to learners who are not physically present in a classroom [15]. Also, it provides equity in educational opportunities by allowing access to quality education for those who otherwise would have been denied.

2.2. The advantages and disadvantages of distance learning

The aim of distance education is to provide a strong communication between students and lecturers. That's why there are also disadvantages as well as advantages of distance education.

The main advantage of distance learning is that the students can study wherever, whenever, and whatever he/she wants. So, it can be said that flexibility is the most important advantage of distance learning. The other advantages of distance learning are as follows:

- The students have the convenience of course materials being delivered to his/her home or office.
- Students may gain useful, transferable skills, such as planning and research.
- Students can make their feedback easily.
- There is no waste of time in transport.
- Accessing students without face-to-face learning opportunities.
- Distance learning provides just-in-time learning.
- Distance learning is associated with technology more than face-to-face learning.
- Distance education can reach a wider audience.
- Distance learning can facilitate greater learner-instructor interaction.
- Distance learning can equalize access to education.
- Distance learning makes information and lecture notes open to everyone.
- Distance learning minimizes the costs of stationery.
- Distance learning increases the effectiveness of education through the use of items such as sound and image.

Although distance learning has numerous benefits, it has some disadvantages that are listed as follows:

- There is a lack of eye contact between the students and the lecturers.
- It can be occasional Internet provider downtime.
- Student must be more active in education environment.

- The cost of developing course materials is too much, and it is needed more time to prepare course materials.
- There is unconsciousness in the use of educational technology.
- Distance learning is not suitable for undisciplined learners or inflexible instructors.
- Laboratory and experimental courses cannot be given remotely.
- Students who have little technological knowledge cannot follow the courses.
- Students and instructors need to take technical training and support.
- Some of the students cannot access the necessary facilities, such as computers, Internet, etc.

2.3. Types of distance learning

In general, distance education is collected under two main headings:

i. Synchronous

ii. Asynchronous

Synchronous learning requires all students to participate the classes at the same time. The method of delivery is usually interactive and includes Internet chat sessions, teleconferences, telecourses, and web conferencing [16]. Synchronous distance education is less flexible than asynchronous distance education because synchronous distance education requires all enrolled students and the teacher to be online at a specific time. Asynchronous instructions do not require simultaneous participation of all students in the class, so it is more flexible. Asynchronous instruction gives students the freedom to interact with the material and instructor at a time that is convenient for them [16].

Internet-based distance education has become a specific focus for at least three reasons according to the Institute for Higher Education Policy (IHEP) [17]:

First, Internet is quickly becoming the predominant technology in distance education, because of its increasing telecommunications bandwidth capabilities. Second, Internet-based distance education especially asynchronous instruction mode allows the teaching and the learning processes to occur "at any time and any place." Provision of the interactive learning activities at any time and any place has become the most important characteristic of this technology. Third, Internet-based distance education is, in many ways, fundamentally different from traditional classroom-based education.

Internet-based distance education must have the following features [18]:

- The identification and management of users
- Preparation of online course contents
- Managing courses

- Monitoring and analyzing student behaviors
- Assessment of students' achievement status
- The creation and management of interactive communication media

2.4. Learning management systems

Computers and computer networks are rapidly becoming the preferred long-distance communication tool, and they are evolving as a major resource in distance education. There are many computer-based distance education tools, and the names of the major tools and their web addresses are listed in **Table 1** [19].

In this chapter, we have reviewed the most popular, widely used and well-known learning management systems (LMSs) and included detailed comparison of these systems. Therefore, we include ATutor, Blackboard, Claroline, Desire2Learn (D2L), Docebo, Dokeos, eFront, Moodle, OLAT, and Sakai systems in this chapter. Among the others, Blackboard and Moodle are the two most well-known web-based learning management systems widely used in universities and higher education [19].

2.4.1. ATutor

ATutor is a free and open-source course management system that has a simple and straightforward structure. It is a web-based learning content management system (LCMS) under the GNU General Public License (GPL). It was prepared such that it can be easily used in any type of computer system and all operating systems. ATutor has been used in many universities, institutions, research centers, and educational institutions.

ATutor was implemented in Personal Home Page (PHP: Hypertext Preprocessor), and it includes facilities for teachers and students. Students can change the learning environment based on existing templates, send messages, and collaborate on courses. On the other hand, instructors can manage the courses, store files, and create workgroups. At the same time, in ATutor, people with disabilities were considered, so ATutor was arranged to use easily.

ATutor has blog, forum, photo gallery, glossary, site map, chat, directory, tests and surveys, and MyTracker tool, which tracks users' navigational patterns. It supports Sharable Content Object Reference Model (SCORM) standards and Instructional Management Systems (IMS) packets. It is available in more than 20 languages. Some video conference softwares such as Adobe Connect, BigBlueButton, and OpenMeetings modules can be integrated in ATutor. **Figure 1** shows web page for an ATutor course.

2.4.2. Blackboard

Early in 2006, owners of Blackboard Learning System and WebCT decided to join their forces and merge two companies under the existing name of one of them—Blackboard. The new entity continues to support both systems [19]. Also, Blackboard Learning System acquired Angel Learning System in May 2009. So the Blackboard Learning System is a web-based

Tools	Web addresses
Adobe Connect	http://www.adobe.com/products/adobeconnect.html
AkademikLMS	http://www.akademiklms.org/
ANGEL	http://www.angellearning.com/community/highered.html
ATutor	http://atutor.ca/
Avilar WebMentor	http://www.avilar.com/learningmanagement/lms.html
Blackboard (WebCT)	http://www.blackboard.com/
Bodington	http://bodington.org/
Claroline	http://www.claroline.net/
CoursePark	http://www.coursepark.com/
Desire2Learn	http://www.d2l.com/
Dokeos	http://www.dokeos.com/
DotLRN	http://dotlrn.org/
Drupal	http://drupal.org/
eFront	http://www.efront.gr/
Enocta	http://www.enocta.com/enocta/web/pdefault.aspx
eStudy	http://estudy.sourceforge.net/
ETUDES	https://myetudes.org/portal
Fle3	http://fle3.uiah.fi/
ILIAS	http://www.ilias.de/
IntraLearn SME	http://www.intralearn.com/
Janison Toolbox	http://www.janison.com.au/
Moodle	http://moodle.org/
OLAT	http://www.olat.org/
Perculus	http://www.perculus.com/
RCampus	http://www.rcampus.com/
Sakai	http://www.sakaiproject.org/
SimplyDigi	http://www.simplydigi.com/products.html

Table 1. The distance learning tools and web addresses.

commercial distance education system dedicated to education containing teaching resources and straightforward user hierarchy. It allows instructors to post course information and materials as well as readings and assignments.

Thanks to the flexibility of the Blackboard Learning System, it is easy to design a course curriculum or study schedules, and the continuation of education courses go on flawlessly. Not only can the teacher shift page layouts including font types or colors but also choose texts and icon links. It also facilitates interaction between users, who can have basic discussion, and offers other collaborative tools.

The idea behind the Blackboard Learning System is to let teachers deliver course content, especially adjusted to large courses at lower levels. The role of an administrator of the system

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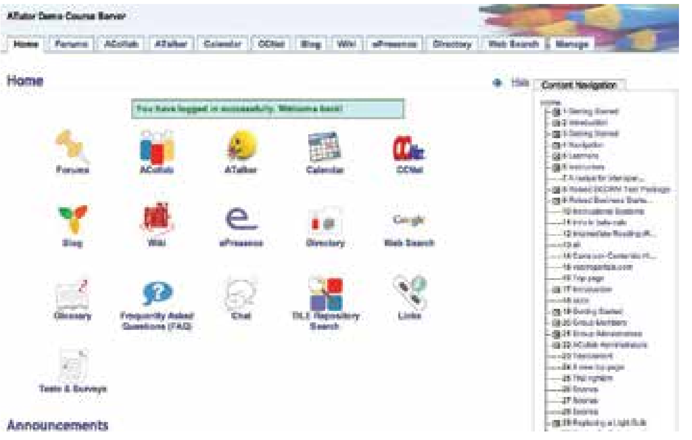

Figure 1. ATutor Course Web Page.

is limited to conducting basic operations such as initial course and teacher registration. The administrator is not overly dependent on it as many course management tasks, such as student and course content registration or tests and statistics check, can be carried out by a teacher. The system consists of many communication and discussion features enabling active participation of students [20]. The possibility of the use of multimedia, an instructional option, is willingly utilized by teachers. **Figure 2** shows the web page for a Blackboard course.

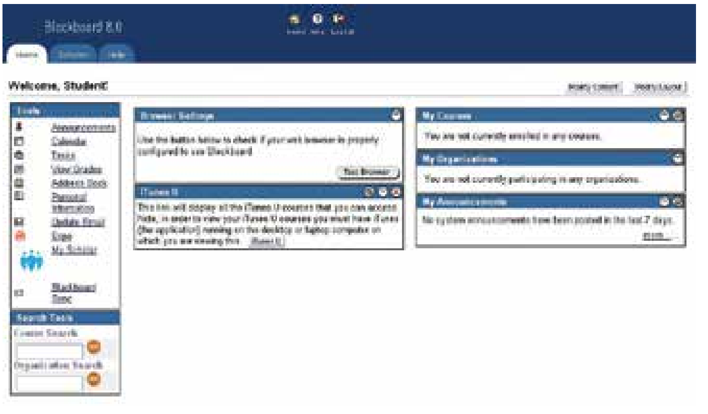

Figure 2. Blackboard Course Web Page.

2.4.3. Claroline

Claroline is an open-source e-learning and e-working platform. It can work on both Windows and Linux server systems. Claroline provides the ability to manage public education activities on the web and to create effective online courses. There is a large community of users and software developers worldwide.

In Claroline Learning Management System, a user has three roles. These roles are student, teacher, and administrator.

GNU/Linux, BSD, Unix, Windows (9x, ME, NT4, 2000, XP, Vista, and 7), or Mac OS X operating systems, Apache, IIS or Wampler web servers, PHP and MySQL database server should be installed on the web server where Claroline is installed. It is under the GPL.

Two language options, which are website language and course language, are available in Claroline. It has been used in more than 100 countries and translated into 35 languages. However, some languages such as Turkish are not supported completely and some sections are still awaiting translation.

Claroline has rich interaction tools such as chat, forum, and wiki, but there is no survey functionality and whiteboard application. It does not require any programming skills to install, manage, and use. It supports SCORM standards. Claroline allows user lists to be created and user statistics to be seen. User groups can be created in courses. **Figure 3** shows a web page from Claroline.

Figure 3. Claroline Course Web Page.

2.4.4. Desire2Learn

Desire2Learn, which is also known as Brightspace Learning Management System, is another educational learning management system. It is based on competency education and provides a cloud-based learning suite.

Desire2Learn is a commercial educational system that supports mobile learning and web conferencing. It also has some features such as exams, discussions, assignments, quizzes, grades, and portfolio-based activities. D2L supports foreign languages and mathematical notations. D2L also includes a learning repository, course creation tools, an e-portfolio module, mobile delivery, analytics, and lecture capture facilities. **Figure 4** presents web page of Desire2Learn.

2.4.5. Docebo

Docebo LMS platform is a learning management system that is based on SaaS/cloud platform. With Docebo, users can organize, track, and distribute online courses for formal learning. The instructors can create users as well as groups and create reports about them. It was offered as open source but it is not available as open source for a while. Although Docebo is offered for education, now it is primarily used in the corporate sector.

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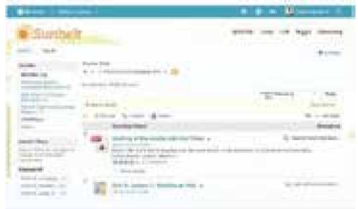

Figure 4. Desire2Learn Course Web Page.

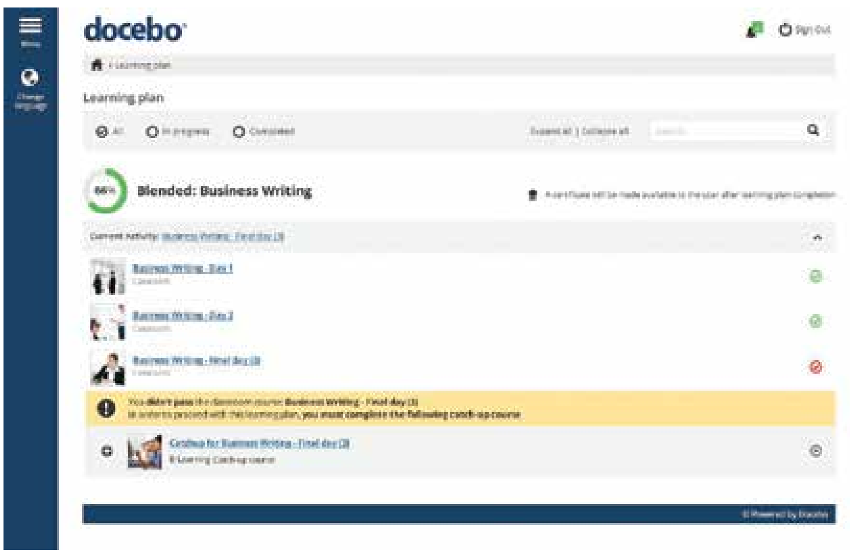

Figure 5. Docebo Course Web Page.

Docebo is under the GPL, so it has no licensing cost. It is compatible with SCORM, Aviation Industry CBT Committee (AICC), and xAPI. It has a component-based architecture and works with PHP and MySQL database.

Docebo has interfaces for video conferences. It is integrated with Adobe Connect, BigBlueButton, Cisco WebEx, Citrix GoToMeeting, OnSync by Digital Samba, and TeleSkill Live. Also, it has integrations with Google Apps, WordPress, and Vivocha.

Docebo is available in more than 30 languages and more than 10 countries. This platform is mobile-ready platform, so it includes mobile learning. The features of Docebo are blogs, course catalogs, labels, and discussions. **Figure 5** shows a course web page from Docebo.

2.4.6. Dokeos

Dokeos is an online and open-source course management system that is widely known and freely available. It is also a learning content management system based on MySQL database and written in PHP language. Dokeos is based on Drupal, which is a content management system. It is available in standard and Professional (PRO) versions.

Figure 6. Dokeos Course Web Page.

Dokeos is used in more than 60 countries, and it has been translated into 34 languages. It features a variety of e-learning templates and e-learning course authoring tools. The features of Dokeos are documents, announcements, tests, agendas, forums, links, tracking tools, and chats [21].

Dokeos supports mobile and cloud learning. Also, it supports SCORM, AICC and Tin Can API compliant. Portals and assessments can be used in Dokeos system; on the other hand, it has agenda, forums, discussion forums, chat, videoconference, open questions, and assignments. It is fully compatible across all browsers and platforms. Web page of Dokeos is presented in **Figure 6**.

2.4.7. eFront

eFront is a modern learning, which is also known as a course management system or learning management systems or virtual learning environment, and an educational platform. eFront is designed to help creating online courses. It has many features such as project management, extended statistics, files management, reports generators, assignments builders, internal messaging system, forum, calendar, chat, survey, etc. It supports SCORM standards.

eFront is a multilingual platform. It offers two types of language files: machine translated and human translated. It supports 48 languages. While 18 of these languages are machine translated, 30 languages are human translated.

This learning management system is PHP based and open source. eFront runs on GNU/Linux, Microsoft Windows, and any other operating system that supports PHP 5.1+ and MySQL 5+. It is under the Common Public Attribution License (CPAL) license. eFront supports Unicode and LDAP, and uses 3-tier architecture with low bandwidth connections.

eFront is content friendly by using presentations and videos. It has multiple types of test and questions. This course management system can collect and analyze surveys. It supports the blended learning. Some video conference software such as Adobe Connect, BigBlueButton, and OpenMeetings can be used with eFront. A sample course page is given in **Figure 7**.

2.4.8. Moodle

Moodle is an online course management system that is widely known and freely available. The word Moodle stands for "Modular Object Oriented Dynamic Learning Environment" and was

Figure 7. eFront Course Web Page.

created by Martin Dougiamas who is a computer scientist and an educator at a university in Perth, Australia [22].

Moodle is a software package that it is used to create Internet-based courses and their websites. Moodle is used in 234 countries, providing support for 139 languages, and has 88,204,960 registered users according to Moodle statistics on the Moodle website in July 2016. There are currently 10,106,758 registered courses and 70,872 active sites that have been registered from those countries.

Moodle is utilized by both institutions and individuals. The list of the former is long, including universities, high and primary schools, governmental departments, military, and healthcare organizations as well as airlines or oil companies. Homeschoolers, independent educators, and special educators are among the individual users.

Moodle, a PHP-based open-source online learning system, has been used since 2002 as a distance education tool, and has various versions supported by Windows, Linux, Unix, and Mac OS X operating systems. The latest version of Moodle is Moodle 3.1.1, released on 11 July 2016. Moodle is under the terms of the GNU General Public License (GPL). There are documents for use, training, and online help in Moodle. Moodle has 14 different activity types such as assignments, chat, choice, database, external tool, feedback, forum, glossary, lesson, quiz, SCORM, survey, Wiki, and workshop.

A number of programs, namely PHP, which is a script language embedded into html codes that work in a server-side; MySQL, which is a database management system that can run in the background and can respond to requests, such as a high-performance web server; and Apache, which is an open-source software web server that is completely free and has a high performance, are required before the Moodle program is set up.

Moodle supports mobile learning, so it has its own Moodle Mobile application. Moodle Mobile supports currently 15 languages. It has responsive design for phones and tablets. Users can download and view some course resources. A course web page from Moodle is presented in **Figure 8**.

2.4.9. OLAT

OLAT is an abbreviation of the words Online Learning and Training. OLAT is a Java-based open-source learning management system that was developed in 1999. OLAT is under the

Apache 2.0 Open Source License. OLAT has forums, chat, blogs, surveys, grading and submission modules, wikis, quizzes, and discussions. It allows monitoring the effectiveness of learners and tutors.

OLAT is multilingual and available in fifteen languages. OLAT runs on Unix, Linux, OpenBSD, FreeBSD, Windows, and Mac OS X operating systems. Java SDK, Apache as a web server, Tomcat Servlet Engine as an application server, and MySQL or PostgreSQL as database are required to install OLAT. It supports SCORM, IMS Content Packaging, and OTI standards. A main web page of OLAT is displayed in **Figure 9**.

Figure 8. Moodle Course Web Page.

Figure 9. OLAT Course Web Page.

2.4.10. Sakai

Sakai is a free learning system that is designed for educational institutions. It is a Java-based LMS. It has been launched as a "Sakai Project" supported by the Mellon Foundation.

http://dx.doi.org/10.5772/65222

Sakai is a free and open-source course design platform. It is web-based and platform-independent application with many features such as supporting training. It can run on CentOS, Debian GNU/Linux, Fedora, Gentoo Linux, Mac OS X server, Microsoft Windows, Red Hat Enterprise Linux (RHEL), Sun Solaris, SuSe Linux, and Ubuntu operating systems. It can be downloaded from the Internet for free, and it works interactively with both MySQL and Oracle database management systems.

Sakai has forums, chat rooms, message center, assignments, grade book, discussions, syllabus, wikis, and WebDAV. It is designed to present mathematical notation such that it can display LaTeX equations on most pages. Sakai is under the Educational Community License (ECL). It is available in more than 20 languages.

Some video conference software such as Adobe Connect, BigBlueButton, Kaltura, and OpenMeetings can be integrated in Sakai, and it has IMS Learning Tools Interoperability (LTI) standards. **Figure 10** shows a sample web page for a course from Sakai.

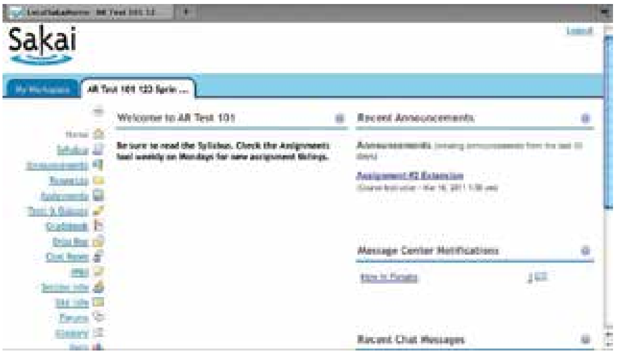

Figure 10. Sakai Course Web Page.

2.4.11. *Comparison of learning* management systems

In the below sections, we provide comparisons among the most similar learning management systems, and in **Table 2**, all comparisons of all learning management systems are summarized.

2.4.11.1. *ATutor, eFront,* and *Moodle*

ATutor is a PHP application and it has some registered installations such as Moodle.

ATutor seems like a down-sized version of Moodle with a slightly more technical look than eFront. But the development on its modules are rather limited [23].

2.4.11.2. *Blackboard and Moodle*

The Blackboard Learning System (i.e., WebCT) ensures variety in course content and materials. In addition, the Blackboard Learning System assists students in their offline efforts. Curriculum

	ATutor	Blackboard	Claroline	D2L	Docebo	Dokeos	eFront	Moodle	OLAT	Sakai
Price	Free	Commercial	Free	Commercial	Commercial	Free but it also has commercial version	Free	Free	Free	Free
Open source	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
License	GPL	N/A	GPL	N/A	GPL	GPL	CPAL	GPL	Apache 2.0	ECL
Type	LCMS	LMS	LMS	LMS	LMS	LCMS	LMS	LMS	LMS	LMS
SCORM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Language	More than 20	More than 20	35	More than 10	More than 30	34	48	139	More than 15	More than 20
Countries	N/A	More than 50	100	N/A	More than 10	More than 60	More than 50	234	More than 30	20
Written in	PHP	N/A	PHP	PHP	PHP	PHP	PHP	PHP	Java	Java
Video conferences integration	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Operating system	Windows, Unix	Microsoft NT								
Servers, Windows, Mac OS X	Windows, GNU/Linux, BSD, Unix, Mac OS X	Windows, Linux, and Mac OS X	Cross-platform	Cross-platform	GNU/Linux, Windows, Cent OS, Windows Server 2003	Windows, Linux, Unix, and Mac OS X	Cross-platform	Cross-platform		
Database server	MySQL	N/A	MySQL	MySQL	MySQL	MySQL	MySQL 5+	MySQL	MySQL, PostgreSQL	MySQL, Oracle
Web server	Apache, Zeus, lighttpd, Abyss, Zazou Mini Web Server, Microsoft IIS, and Jana-Server	N/A	Apache, IIS, Wampler	N/A	Apache, IIS	Apache	Apache	Apache	Apache	Apache Tomcat 7, Apache Http Server
Mobile learning support	Yes, but works still continue	Yes	No	No (only for Brightspace)	Yes	Yes	No, but it can be used with mobile phones and tablets	Yes	No	Yes

Table 2. The comparison of all popular learning management systems.

design is supported by the two systems by providing course templates, thanks to which instructors can deliver course materials, define study schedules, and plan class activities.

Regarding communication and discussion, both Blackboard and Moodle deliver discussion forums and chat rooms together with exchange of e-mails and files.

The Blackboard Learning System also provides private folders and internal e-mail for students and gives them an option of making their own notes. As for performance assessment, systems incorporate assessment and grading functions.

Course administration is embraced again by both tools by facilitating uploading of student data and course data in batches. The Blackboard Learning System is also equipped with direct data interfaces. It should be noted that there are certain similarities between Blackboard and Moodle such as option of student enrollments in courses, access to discussion forums, or taking quizzes and tests.

The Blackboard Learning System and Moodle are about equal in terms of administrative features, collaboration, and instruction methods.

Other common features are supporting file upload (e.g., Word, PowerPoint, audio), being SCORM compliant, allowing grading, providing course calendar, and monitoring students' participation.

2.4.11.3. Blackboard, eFront, and Sakai

The Blackboard Learning System is superior to Sakai in terms of administrative features and course development. But in terms of collaboration and instruction methods, both are very similar.

When eFront and Blackboard are compared, it is observed that eFront is superior to Blackboard in terms of administrative features but they are about equal in terms of course development and instruction methods.

Sakai is superior to eFront in terms of collaboration.

2.4.11.4. D2L (Brightspace) and eFront

eFront is superior to D2L (Brightspace) in terms of administrative features but in terms of collaboration, course development and instruction methods both of them are about equal.

2.4.11.5. D2L, OLAT, and Sakai

D2L (Brightspace) is superior to OLAT in terms of administrative features and course development, but for collaboration facility, both of them are about equal.

D2L (Brightspace) is superior to Sakai with respect to instruction methods used.

2.4.11.6. Dokeos, Docebo, and eFront

Docebo is superior to eFront with respect to administrative features and course development. But in terms of collaboration methods and instruction methods, eFront and Dokeos are very similar.

2.4.11.7. Moodle, Dokeos, and OLAT

Dokeos looks better and less complex than Moodle in terms of interface [23].

But Moodle is superior to OLAT in terms of administrative features, collaboration, course development, and instruction methods.

2.4.11.8. Moodle and Sakai

Unlike Moodle, Sakai is mainly implemented in Java and can cause some problems in older versions of browsers [23].

Moodle is superior to Sakai in terms of administrative features, collaboration, and course development.

2.4.11.9. OLAT and Sakai

Sakai, similar to OLAT, is a Java-based e-learning system developed by an international alliance of universities, colleges, and commercial affiliates; and both have very similar properties [24].

2.4.11.10. OLAT and the others

Although most of the other e-learning applications in this chapter are PHP based, OLAT (Online Learning and Training) is based on Java and is Apache Licensed [24].

eFront and Moodle are superior to OLAT in terms of administrative features and course development.

3. Conclusion

In this chapter, the literature about distance education and learning management systems are summarized. This chapter also presents a brief comparison of some of the most significant learning management systems used for education.

In summary, the history of distance education shows a constant state of evolution. A stream of new ideas and technologies exist in the historical view of distance education. It is also observed that nontraditional education tries to blend with traditional education while meeting the changing learning theories and developing technologies [13].

The Internet-based distance learning model can be defined as a transmission of educational content with the use of text, image, video, and audio files over the Internet, online or offline. According to the Institute for Higher Education Policy (IHEP), the Internet-based distance education has gained a special status for three basic reasons. First of all, the Internet has become the predominant technology in distance education, due to its increasing telecommunications bandwidth capabilities. Second, the Internet-based distance education allows the teaching and learning process to happen "at any time and any place." Asynchronous interactive learning environments, especially, have become the signature characteristic of this field. Finally, the Internet-based distance education is, in many ways, fundamentally different than traditional classroom-based education hence attractive for learners [17]. The main difference is that the Internet-based distance education removes the physical barrier and time constraints for students and lecturers.

Within the framework of this study, the open-source learning management systems especially Moodle are widely used particularly in universities and higher education institutions. In general, the commercial learning management systems especially Blackboard are superior to open-source learning management systems in terms of administrative features; however, according to instruction methods that are employed, the open-source learning management systems especially Moodle are superior to the commercial learning management systems. According to existing literatures [25], Moodle still comes out as the top used system among the open-source LMSs. This result also supports our observations that are explained in this chapter.

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Chapter 2

Social Collaboration Style Preferences and Cognitive Receptivity to Technological Change and Innovation in Open and Distance e-Learning

Melinde Coetzee

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65220

Abstract

The proliferation of online courses in open and distance e-learning higher education contexts brought attention to the role of social collaboration activities in enhancing student learning. Constructive social collaboration in an e-learning environment is influenced by the interaction dynamics of the relevant virtual learning community. Social learning involves the acquisition of knowledge and skills relevant to the individual's unique work or learning context through collaborative endeavours and interactions that often include the use of technological tools such as web-based platforms and social media technological applications. This chapter focuses on how the social collaboration style preferences of members of the virtual learning community relate to their cognitive receptivity to technological change and innovation. The practical implications for virtual learning in open and distance e-learning contexts are outlined.

Keywords: social collaboration, social learning, virtual learning community, cognitive receptivity to technological change and innovation, self-other regulation

1. Introduction

Virtual learning environments and online learning platforms have become characteristic of open and distance e-learning institutions to support online teaching and learning [1]. More specifically, the proliferation of online courses in open and distance e-learning higher education contexts brought attention to the role of social collaboration online activities in enhancing student learning [2, 3]. The adoption of virtual learning systems such as online learning platforms, e-learning applications and collaborative virtual learning communities is a new breed of educational technology that supports enhanced student learning experiences through a variety of online teaching and learning tools [1]. In this regard, higher education institutions that stay abreast with the latest information and communication technological developments are seen to be a driving force in preparing graduates to become valuable human capital that supports the performance and competitiveness of successful organisations in today's knowledge- and service-driven economy [1, 4]. In the light of constant technological innovation being a hallmark of successful companies, employers place high value on the digital citizenship and cognitive receptivity to technological change and innovation as important twenty-first-century skills for graduates' work readiness [4, 5].

Research has underlined the importance of studying dispositional and other person-related antecedents to individuals' cognitive receptivity to change and the adoption of new technologies in organisational context [4, 6, 7]. This is partly because of social psychology literature indicating attitudes, motivations and beliefs as significant predictors of behaviour [4]. The theory of reasoned action [4, 8] also postulates the link between beliefs and attitudes and behavioural intentions in the use of technology (i.e. electronic or digital products or services [9]). Numerous researches have been conducted on the factors influencing individuals' acceptance and adoption of technology [9–11] and openness to organisational change [6]. However, significantly less attention has been paid to how individuals' social collaboration learning styles in a virtual learning community influence their cognitive receptivity to technological change and innovation. The present study attempts to fill this research void by exploring the relationship dynamics between these two cognitive-behavioural constructs (social collaboration style and cognitive receptivity to technological change and innovation) in the virtual learning environment context provided by open and distance e-learning. This chapter explores whether individuals' social learning collaborative style preferences significantly explain the variance in their cognitive receptivity to technological change and innovation. Understanding the relationship dynamics between these two cognitive-behavioural constructs contributes to the emerging virtual learning research literature on factors influencing individuals' responsiveness to technological change.

1.1. Social collaboration style preferences

Social learning involves the acquisition of knowledge and skills relevant to the individual's unique work or learning context through collaborative endeavours and interactions that often include the use of technological tools such as web-based platforms and social media technological applications [3]. Social learning theory [12] postulates that learning takes place among and through other people and requires active participation in a social world. Social learning is an interpersonal and collaborative endeavour requiring significant social interaction [13]. The processes of participation and interaction are of significance because they provide, condition and sustain the context of knowledge generation and learning for the virtual community [14, 15]. Social learning through technological platform collaboration (for example, group debate forums) involves socially shared regulation and social regulation in coordinating and regulating work on a joint task [16]. Social constructivism postulates that in communities of collaborative learning individuals are autonomous in their self-expression, in the authoring

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of their own content and in sharing that content with others in efficient and meaningful ways [17]. However, individuals differ in terms of their preferred way of interaction with others in a collaborative social learning set-up. Coetzee [18] differentiates between four social collaboration style preferences: (1) active-initiator, (2) independent-evaluator, (3) reflective-evaluator and (4) passive-independent.

- *Active-initiators* enjoy taking the lead in initiating discussions and debates because they see the collaboration as an opportunity to demonstrate their own insights and originality. They regulate the contributions of others by taking a critical evaluative stance and commenting on other members' ideas and viewpoints. Apart from enjoying bringing their own innovative and creative ideas to the group debate, active-evaluators also enjoy inviting debate from other members because their contributions are seen to stimulate new insights [18].
- *Independent-evaluators* tend to regulate others by preferring to ignore the ideas and viewpoints already posted; they would rather try to contribute their own unique ideas about the subject matter in order to bring a new perspective to the debate. They prefer to know the facts first about an idea before debating its importance and meaning. Independent-evaluators are often seen by other members as dominating the debate by their preferred critical and argumentative stance and questioning of other members' contributions and viewpoints [18].
- *Reflective-evaluators* tend to regulate others by responding to the ideas and viewpoints of other members. Their approach is constructive by building on and adding to the contributions of the group members. Reflective-evaluators enjoy encouraging other members by showing their appreciation for members' contributions, pointing out the importance and practical uses and limits of ideas and viewpoints, and searching for and finding new ideas and information that may help the group in completing the joint task successfully [18].
- Members with a *passive-independent* preference tend to avoid regulation of other members. They prefer to work on their own, independent from other group members in completing the task. The passive-independent prefers to act as an impartial observer of the group's ideas and debates and tends to focus on other members' responses and comments rather than contributing their own ideas. They are usually slow to catch up with the group debate and tend to be the last one to make any contributions. They find it difficult to participate in collaborative social activities and would rather prefer to keep their ideas and viewpoints to themselves [18].

Table 1 provides an overview of the dominant personality-based characteristics of the four social collaboration style preferences in a typical virtual learning setting.

Limited research has been conducted on the four social collaboration preferences postulated by Coetzee [18]. Social regulation theory [13] suggests that facilitative and directive forms of other-regulation influence the process of collaboration and quality of socioemotional interaction between group members within the community of collaborative learning. The active-initiator and independent-evaluator preferences represent characteristics of a directive other-regulation orientation (i.e. taking an instructive role in guiding the joint activity and others and controlling and/or dominating others' attempts at making task contribution [13]), while the reflective-evaluator represents characteristics of a facilitative other-regulation orientation (i.e. high-level content processing via monitoring for content understanding and improved task and content quality [13]). Directive other-regulators tend to limit opportunities for other group members to regulate, contribute and participate in the joint task by preferring that their own contributions remain central to the discussion [13]. The facilitative other-regulators tend to regulate the collaboration and task quality by inviting and encouraging others to participate and contribute to the joint tasks and by facilitating cognition and content understanding through a meta-cognitive monitoring and guiding approach [13].

Social collaboration style preferences	Active-initiator	Independent-evaluator	Reflective-evaluator	Passive-independent
Other-regulation orientation	Initiating debate Bring own innovative and creative ideas to debate and invite debate to stimulate new insights	Critiquing debate to stimulate new perspectives—prefer to contribute own unique ideas about subject matter	Reflecting on and building on others' ideas/viewpoints —searching for and finding new ideas and information to support group—encouraging others/ appreciative stance	Impartial observer—slow to catch up on debate, keep own viewpoints to self Resistant to contribute
Dominant regulation style	Directive style Proactive initiator/ instructor (self-directed)	Directive style Proactive evaluator/ instructor (self-directed)	Facilitative style High-level content processing—monitoring for content and process (other-directed)	Passive-reluctant style (other-directed)
Collaboration level	High	High	High	Low
Openness to change level	High	High	High	Low

Table 1. Overview of the dominant personality characteristics of the four social collaboration style preferences exhibited in a virtual learning setting.

Learning that requires collaboration in a virtual learning setting calls for proactive self-regulated learning from students [19]. As such, social collaborative regulation is influenced by the self-regulated learning capacity of the virtual learning community members. Self-regulated learning denotes the self-initiated management of thoughts, feelings and behaviours, which are used to achieve learning goals [20] and the extent to which participation in the virtual community will be initiated. Participation in the collaborative learning tasks refers to the amount of energy or effort that students devote to the learning activity [19]. Active learners tend to adopt a participatory learning style such as those represented by the active-initiator and independent-evaluator collaboration styles. Members with a participatory style prefer actively processing information by participating in learning activities and debates; they

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consistently show initiative and accountability towards the successful completion of the learning task [19] and therefore tend to exhibit a high level of self-directedness and openness to change. On the other hand, collaboration styles such as the reflective-evaluator and passive-independent collaboration styles typically prefer working in individual learning spaces allowing them to reflect on the information obtained in solitude. Reflective learners such as those represented by the reflective-evaluator and passive-independent collaboration style types generally tend to exhibit lower levels of self-directedness and more resistance to change in a collaborative leaning community because they tend to be more dependent on the participatory or directive and/or facilitative leadership energy of active learners.

1.2. Social collaborative learning and cognitive receptivity to technological change and innovation

In open and distance e-learning virtual learning communities, the affordances of technology offer important opportunities and challenges for enhancing students' learning processes and experiences, including the digital and personal capabilities that are foundational to their social competency and their personal and professional success [15]. Collaborative social learning in distance e-learning methodologies offers to distance learning students the opportunity to collaborate and interact with other members of the virtual learning community, which facilitates a sense of belongingness, reduces the feeling of loneliness and encourages learning [2]. Collaborative learning endeavours in virtual learning educational contexts offer cognitive advantages to students and positively influence the development of personality traits and personal skills that are beneficial for future autonomous or cooperative learning and working [2]. Research has indicated that social collaborative learning increases student achievement levels, helps e-learning students to be more conducive to long-term successful learning and develops high-level cognitive and problem-solving skills regarded as important by employers for their work readiness [2].

Virtual learning environments require a cognitive openness to new technological tools and platforms used in open and distance e-learning contexts for student learning. Such technologies include the use of web-based collaborative learning communities such as group discussion forums [19]. The extent to which an individual enjoys or is willing to trying out new applications, social media tools and applications and technological products reflects their cognitive openness to technological change and innovation [21]. Adopting new technologies and engaging in learning how to use and apply a new technological product are seen as an aspect of the individual's lifelong learning and development [21].

Theories of self-regulated learning provide a useful lens to understand the influence of self-initiated management of thoughts, feelings and behaviours in achieving specific learning goals in virtual learning communities [20, 22]. Both cognitive receptivity to technological change and innovation and social learning collaborative styles relate to the use of self-regulatory strategies and responsiveness. Constructive social collaboration in an e-learning environment is influenced by the interaction dynamics of the relevant virtual learning community [16]. Group collaboration involves self-regulatory cognitive processes in the regulation of others through the coordination and negotiation of varying group members' perspectives [13]. Research shows that individual members differ significantly in the cognitive processes they apply in other regulation when working on collaborative group tasks [13, 23]. Similarly, openness to technological change and innovation involves self-regulatory cognitive processes in evaluating new technological products and services, taking risks in bringing new technological products and ideas to the table, seeing the benefits of adopting new technological innovations and devising strategies in trying out new applications, social media tools and technological products [21].

Cognitive receptivity to technological change and innovation is a form of change-oriented employee behaviour that represents agentic traits, such as proactivity and openness to experience, which indicate employees' tendencies to generate change in their social environment [24] and being resourceful in dealing with new and unusual technological experiences [21]. Individuals who are open to the innovation of new technologies generally believe that the new product will help them to change outdated work processes or improve outdated methods for performing work tasks [21]. On the other hand, individuals who are not ready for or who are overly cautious of new technological products and innovations may become resistant towards adopting the change represented by the new technological product [6, 21]. It stands then to reason that individuals with differing social learning collaboration style preferences may exhibit different levels of cognitive receptivity to technological change and innovation due to the inclination to function either more autonomous or independent from others or to actively initiate and regulate interaction with other members of the virtual learning community. The study presented in the following section explored the empirical association between individuals' social collaboration learning style and their cognitive receptivity to technological change and innovation as exhibited in a virtual learning environment context.

2. Method

2.1. Participants and procedure

Ethical clearance and permission to conduct the research were obtained from the management of the university. A random sample of working adults (*N* = 160; 67% black and 33% white people; 59% females and 41% males) enrolled for further studies at an open and distance higher education institution participated in the study. The participants were employed in the human resources and financial fields. The participants had an age range from 25 to 50 years with 80% in the early career stage (exploration and establishment phase) of their lives (25–40 years). Data were collected by means of a web-survey.

2.2. Measuring instruments

The participants' social collaboration style preferences were measured through the *social learning styles inventory* (SLSI) developed by Coetzee [18]. The SLSI uses a 5-point Likert-type scale (1 = never; 5 = almost always) with 45 items that measure individuals' orientation towards the use of social media tools and applications in collaborative learning activities: active-initiator (17 items; e.g. '*I prefer to initiate new ideas and stimulate the debate*'); reflective-evaluator (14 items; e.g. '*I respond to ideas and viewpoints by pointing out flaws in members' arguments in order to improve the reasoning/ideas*'); passive-independent (7 items; e.g. '*I prefer to act as impartial observer of the ideas and debates*') and independent-evaluator (7 items; e.g. '*I prefer to ignore the ideas and viewpoints already posted and try to contribute my own unique ideas about the subject matter in order to bring a new perspective to the ideas*'). For the present study, the overall subscale Cronbach's α coefficients ranged between 0.79 and 0.97 (high internal consistency reliability). Previous research indicated construct validity of the scale [18].

The participants' levels of cognitive receptivity to technological change and innovation were measured through the *technological change receptivity scale* (TCRS) developed by Coetzee [18, 21]. The scale consists of 28 items and three subscales with a 6-point Likert-type response scale ranging from 0 (never) to 5 (almost always): (1) ingenuity (9 items; e.g. *I see myself as resourceful in dealing with new and unusual technological experiences/I like to take risks in bringing new ideas or products to the table*; (2) openness to change (11 items; e.g. *I believe that the innovation of new technological products helps create the future/I am quick to try out new apps and technological products*) and (3) resistant to change (8 items; e.g. *I find it difficult to adopt new technology—I would rather stick to the tried and tested/ I find it scary to try out new technological products*). Evidence of the construct and internal consistency reliability of the TCRS has been provided by Coetzee [21]. In terms of the present study, Cronbach's α coefficients for the three subscales were ingenuity (0.92), openness to change (0.93), resistant to change (0.79) and overall scale (0.90) (high internal consistency reliability). Previous research indicated construct validity of the scale [18, 21].

Demographic data were used as control variables and included: age (coded 0 = ≤45 years; 1 = ≥46 years), gender (coded 0 = male; 1 = female) and race (coded 0 = black; 1 = white). These variables were chosen based on previous research indicating that these variables are important to consider in evaluating individuals' career concerns and openness to change [6].

2.3. Statistical analysis

Bivariate correlation (Pearson's coefficients) analyses were calculated to assess the pattern of relationships between the variables of concern to the study. Point-biserial correlations were calculated for discrete dichotomous variables (i.e. the demographic variables). Canonical correlation analysis (CCA) was used to study the multivariate relationships between the four SLSI scores and the three TCRS scores. CCA is a useful multivariate statistical procedure in human behaviour research because it assesses the association between multiple sets of variables and counteracts type I error.

3. Results

As can be seen from **Table 2**, the practical effect of the significant correlations between the SLSI and TCRS variables ranged between $r \geq 0.23 \leq 0.52$ (small to large effect; $p \leq 0.01$). No significant correlations were observed between resistant to change and the active-initiator, reflective-initiator and independent-evaluator variables. The passive-independent variable had no significant association with ingenuity and openness to change. Age had no significant associations with the SLSI and TCRS variables, while gender had associations of small practical effect ($r < 0.16$; $p < 0.05$) with only active-initiator and reflective-evaluator social learning styles and ingenuity. Race had associations of small practical effect ($r < 0.16$; $p < 0.05$) with only the active-initiator, reflective-evaluator and passive-independent social learning styles.

		M	SD	α	1	2	3	4	5	6	7	8	9	10	11
1	Age	-	-	-	-										
2	Gender	-	-	-	-.06	-									
3	Race	-	-	-	-.22**	.19**	-								
4	Active-initiator	3.87	1.30	.97	.03	-.20**	-.21**	-							
5	Reflective-evaluator	5.00	2.29	.95	.10	-.23**	-.17*	.82***	-						
6	Passive-independent	3.75	1.09	.79	-.004	-.11	.16*	.44***	.45***	-					
7	Independent-evaluator	4.08	1.17	.83	.02	-.20**	-.06	.85***	.76***	.55***	-				
8	Ingenuity	4.55	1.07	.92	-.08	-.16*	-.08	.52***	.48***	.13	.50***	-			
9	Openness to change	5.07	1.04	.93	-.10	-.07	-.10	.47***	.41***	.12	.38***	.80***	-		
10	Resistance to change	3.26	.77	.79	.01	-.05	.08	-.12	-.02	.24**	.03	-.17*	-.30*	-	
11	Overall technological change receptivity	4.29	.65	.90	-.10	-.15	-.07	.49***	.47***	.23**	.49***	.91***	.85***	.14*	-

*** p≤ .001; ** p≤ .01; * p≤ .05 (two-tailed).

Table 2. Descriptive statistics and zero-order correlations.

Canonical correlation analysis was used to study the multivariate relationships between the four SLSI scale scores and the three TCRS scale scores. **Table 3** shows that the full model was significant using Wilks' multivariate test criterion (Wilks' λ = 0.5757, function 1: Fp = 7.83, $p = 0.0001$). The first function of the model was significant and contributed to 56% of the overall explained variation relative to the function. The full model r^2 type effect size (yielded by $1 - \lambda$) was 0.42 (large practical effect), indicating that the full model explains an adequate proportion of the variance shared between the two variable sets. The redundancy index results summarised in **Table 2** show that the social learning styles represented by the SLSI variables was able to predict 20% (moderate practical effect) of the proportion of overall variance in the technological change receptivity variables.

3 provides the canonical coefficients (weights), canonical structure coefficients (*Rc*), canonical cross-loadings (*Rc*) and squared canonical loadings (Rc^2). Overall, only three of the social learning styles (active-initiator, reflective-evaluator and independent-evaluator) significantly predicted the technological change receptivity construct variables with the exception of the resistant to change variable, which also did not contribute much to explaining the technological change receptivity canonical construct variate. The canonical cross-loading *Rc* coefficients indicated that the three social learning styles explained 31% ($Rc = 0.56/Rc^2 = 0.31$, large practical

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effect) of the variance in ingenuity and 22% (Rc = 0.47/Rc^2 = 0.22, moderate practical effect) of the variance in openness to change.

Variate/variables	Canonical coefficients	Structure coefficient (Rc)	Canonical cross-loadings (Rc)	Squared canonical loadings (Rc^2)
Social collaboration style preferences canonical variate variables				
Active-initiator	−0.61	0.93	0.52	0.28
Reflective-evaluator	−1.44	0.84	0.47	0.22
Passive-independent	−0.79	0.19	0.11	0.01
Independent-evaluator	0.00	0.86	0.48	0.23
Technological change receptivity canonical variate variables				
Ingenuity	1.08	0.99	0.56	0.31
Openness to change	0.22	0.83	0.47	0.22
Resistance to change	0.00	−0.27	−0.15	0.02

Overall model fit measures (function 1):
Overall Rc = 0.56
Proportion = 0.32
F(p) = 7.83 (p < 0.0001); df = 12; 405.09
***Wilks' λ = 0.5757
r^2 type effect size: 1−λ = 0.42 (large practical effect)
Redundancy index (standardised variance of technological change receptivity explained by the social collaboration style preferences): Proportion = 0.20.
*** p≤ .0001;

Table 3. Results of the standardised canonical correlation analysis for the first canonical function.

Overall, the active-initiator style (Rc = 0.93), followed by the independent-evaluator (Rc = 0.86) and reflective-evaluator style (Rc = 0.84), contributed the most in explaining the variance in the social learning styles canonical variate construct and in predicting the technological change receptivity variables.

4. Discussion

This chapter explored the association between adult learners' social collaboration style preferences and their cognitive receptivity to technological change and innovation. The empirical results clarified the magnitude and direction of the relationships between these two cognitive-behavioural constructs. As shown in **Figure 1**, the active-initiator style, followed by the independent-evaluator and reflective-evaluator style, contributed the most in predicting adult learners' technological ingenuity and openness to technological change. The participants who had a preference for these three social collaboration styles also exhibited less resistance to technological change and innovation and an openness towards and resourcefulness in dealing with new and unusual technological products and applications. The passive-independent style and attitudes of resistance to technological change contributed less to this association.

The positive association between especially the active-initiator style preference and cognitive receptivity to technological change and innovation suggests that those student participants who enjoy taking the lead in initiating discussions and debates in the virtual community are likely to be keen to demonstrate their ingenuity in using new technological products. This finding corroborates Coetzee's [18] premise that active-initiators generally see social collaboration as an opportunity to demonstrate their own insights and originality. Active-evaluators are high self-other regulators who generally enjoy inviting debate from other members because their own and others' contributions are seen to stimulate new insights [18]. Their strong initiating style appears to be associated with positive perceptions of technology and an eagerness to engage with new technological products and applications.

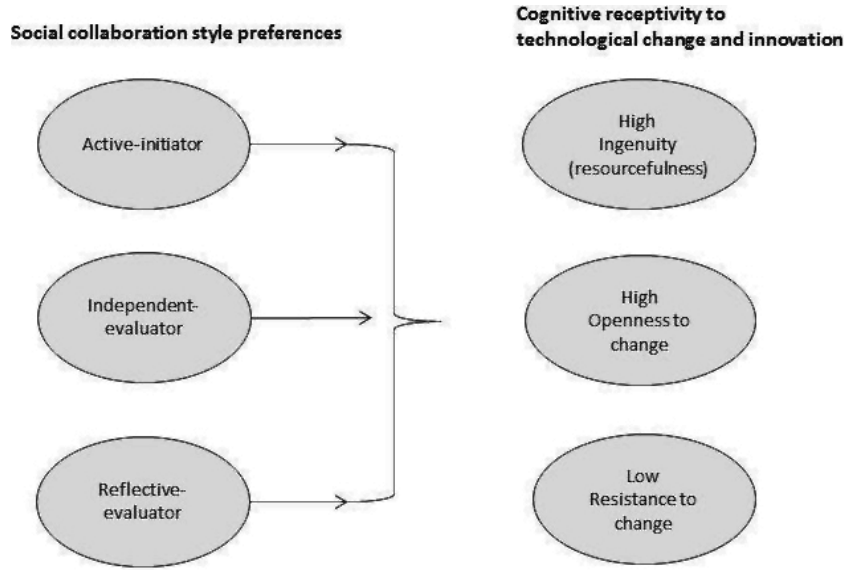

Figure 1. Key finding: association between the social collaboration style preferences and cognitive receptivity to technological change and innovation.

The independent-evaluators also showed a high level of cognitive receptivity to change and ingenuity (resourcefulness in dealing with new technological products and applications), which could be attributed to their preference to bring a new perspective to the debate by contributing their own unique ideas about the subject matter [18, 21]. The results further suggest that the reflective-evaluators' cognitive receptivity to technological change and innovation may be attributed to their preference for constructively building on and adding to the group's contributions. They generally prefer to search for and find new ideas and information that may help the group in completing the joint task successfully [18].

The active-initiator, independent-evaluator and reflective-evaluator style preferences reflect change-oriented behaviour that represents agentic traits such as proactivity and openness to experience. These personality attributes have been associated with peoples' tendencies to generate change in their social environment [24] and being resourceful in dealing with new and unusual technological experiences [21]. Moreover, individuals who exhibit a preference for these three social collaboration styles generally tend to have a more positive perception of their ability to regulate their own and others' behaviour in a virtual learning community setting [13, 18]. It appears from the findings of the study that this sense of control is also likely to be positively extended to their perceptions of digital technological products and innovations. This finding corroborates research that indicated that locus of control influences the way people perceive and interact with information technology [25]. Research has also indicated self-directedness (self-directed learning, self-regulated strategies and self-motivated behaviour) as a powerful precursor of academic performance and goal-oriented learning [25]. Cognitive receptivity to technological change and innovation suggests goal-oriented behaviour in the utilisation of technological products and applications for one's personal growth and development. This view is in agreement with research that indicated positive associations between people's cognitive receptivity to change and innovation and their lifelong learning orientation [21].

4.1. Limitations and suggestions for future research

The findings need to be considered in the light of the limitations of the research design. The maximisation technique utilised in canonical correlation analysis points to the possibility of overestimation that may occur in canonical models due to the amplification of linear composites [26]. Generalisability of the findings to populations in different occupational industries and educational settings is limited by the relative small sample being confined to a specific population in the South African higher education context. Testing the variables on various multicultural populations from various occupational groups may further inform theories on personality variables that influence adult learners' anthropomorphic perception or cognitive openness towards digital technologies in virtual learning contexts. Future studies could consider longitudinal research designs exploring the link between individuals' social collaboration style preferences and their cognitive receptivity to technological change and innovation as their motivational beliefs, digital skills and citizenship, and adaptability develop over time. The measuring instruments used for studying the association between individuals' social collaboration style preferences and their cognitive receptivity to technological change and innovation drew on individuals' subjective perceptions and not actual behaviours. Ascertaining whether these perceptions may promote actual receptivity towards new innovations in technological products and applications needs further investigation by means of longitudinal research designs and additional measures.

4.2. Implications for theory and practice

Notwithstanding the limitations of the research design, the literature and study findings outlined in the chapter contributed valuable insights about the association between adult learners' anthropomorphic perception (cognitive receptivity) of technological products and innovations and their social collaboration style preferences. The value-add of the theoretical and empirical contribution is considered in the light of the little research that has been to date conducted on these constructs in the open and distance e-learning context in South Africa. Theory and research indicated that individual members in the virtual learning community generally differ in the cognitive processes they apply in self-regulation and other regulation when working on collaborative group tasks [13, 23]. These differences influence their cognitive receptivity towards the social learning digital technology that is available for virtual learning contexts. Understanding the relationship dynamics between the two cognitive-behavioural constructs that were discussed in this chapter (social collaboration style preferences and cognitive receptivity to technological change and innovation) contributed to the research literature on factors influencing virtual learners' responsiveness to new technological products and applications.

The new insights and knowledge generated by the research are important in the light of digital literate citizenship regarded as a social demand in today's knowledge and information technology society [25]. Cognitive receptivity to technological innovations and their applications in educational and employment settings has become essential for survival in the contemporary society of knowledge and innovation [21]. Open and distance e-learning educational settings that focus on the application of new information systems and digital technological products and innovations enhance students' learning and prepare them as adult learners for the demands of employers who have to sustain a competitive business in a knowledge and information society [21].

E-learning designers and developers can use the new knowledge and insights demonstrated by the literature and empirical study in the design of e-learning collaborative tasks and activities. Adult learners should learn to understand the importance of digital citizenship and willingness to collaborate and engage with others in a virtual learning community through digital tools of communication and learning. Educators should make adult learners who are resistant or reluctant to engage with others in a virtual learning setting aware of how their social collaboration style preferences potentially influence their willingness to engage with others through digital tools. Adult learners with a passive-independent style preference should understand how their reluctance influences their cognitive receptivity to technological change and innovation, which, in turn, may potentially negatively influence their work readiness and career success in a digital society.

Learners who prefer to act as leaders in a virtual learning community such as those with an active-initiator collaboration style can be encouraged to use their style preference in inviting more reluctant and independent learners (i.e. those with a passive-independent style) to engage with digital technology in contributing their ideas to the virtual learning community. Similarly, independent-evaluators and reflective-evaluators can play a supportive role in the virtual learning community by eliciting participative behaviour from the more reluctant and resistant member. The active-initiator, independent-evaluator and reflective-evaluator style preferences generally tend to have a more positive perception of their ability to regulate their own and others' behaviour in a virtual learning community setting, and it appears that this sense of control is also likely to be positively extended to their perceptions of digital technological products and innovations. Encouraging adult learners' cognitive receptivity to technological change and innovation has become essential in a digital information society.

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Technological advancements in the knowledge-based economy and information society will continue to result in frequent changes in the workplace and the nature of jobs. Developing one's digital social citizenship has therefore become an important aspect of people's lifelong learning and employability.

Educators should also take note that collaborative learning tasks in a virtual learning setting can place high demands on limited cognitive resources, often due to the ill-structured nature of the tasks and lack of clarity regarding the learning goals to achieve through the collaboration. Collaborating with fellow students in a virtual learning setting through social tools, such as discussion forums, for example, requires self-initiated self-regulatory processes apart from the other-regulation processes represented by the social collaboration style preferences. However, research has shown that students often do not self-initiate a high degree of self-directed learning processes and often struggle when engaging in ill-structured learning tasks [22]. Educators and e-tutors can consider scaffolding self-directed learning by providing timely instructional prompts and feedback on the role and contributions made by the virtual community members to the debate. From a cognitive meta-perspective, educators or e-tutors can timely adopt either a directive and/or facilitative style in regulating the participation of students in support of the members' dominant social collaboration style preferences. They can also act as moderators of the quality of the content of the debate and provide feedback to the members of the debate. By identifying the dominant social collaboration style preferences of the various members who participate in the collaborative learning task, strategies to encourage and facilitate optimal and quality participation of all members can be achieved. This type of intervention by the educator or e-tutor can support the learning of members and facilitate the development of the self-directed learning and other regulation qualities required for effective learning in a virtual learning setting. Experiencing successful learning through the use and application of digital technologies may further enhance a receptivity to adapt to changing technological innovations in virtual learning settings.

5. Conclusion

The chapter contributed to the sparse literature and research on the role of personality characteristics in people's ability to accept and adapt to the requirements of a digital information technology-driven society. More specifically, the research findings enhanced understanding of the association between adult learners' social collaboration style preferences and their willingness to engage with new technologies in a digitised learning environment. Exploring this association within the context of a virtual learning environment setting provided valuable insights that contributed to the new emerging research literature on the demands and challenges of open and distance e-learning in a digital society. The new knowledge contributed by the chapter can be used to enhance the learning experiences of the open and distance e-learning student.

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Digital Transformation in School Management and Culture

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65221

Abstract

Quality becomes milestone for enhancing learning and teaching practices through contemporary standards. In this respect, considering the outcomes of transformation is essential. School management is an umbrella of facilitating learning and teaching. Therefore, role of digital transformation in school management is an intensified need to be underlined. In establishing school culture, school management plays an essential role that digital transformation effects the school management and culture for the quality in education. The nature of this research is qualitative. Reflective reports of headmasters are gathered as data to understand the readability and awareness of school management to the digital transformation in the case of North Cyprus. In addition, content analysis is done to realize the upcoming issues in school management and digital transformation. As this focus is demanding for developing countries especially North Cyprus, this research revealed that headmasters have awareness on the use of digital and technological facilities. They are aware on digital transformation although budget and application restrictions are revealed to apply this transformation.

Keywords: culture, digital management, transformation, quality

1. Introduction

Social and cultural values play an important role on institutions while forming the culture. The key point of development of the institutions is to provide vital information for the individuals in the institutions and to represent this in a visible way. This especially allows the cultural structures to be at quality standards in educational institutions.

Today, educational systems and schools can form the basis of stepping forward to the participatory management approach to be at quality standards. By taking into consideration the opinions and considerations of all the components and stakeholders of school administrations, all the decisions and activities could ensure the continuity of the present conception of sustainability [1]. Participation during judgement and coordination and being functional at cooperating is needed in order to create quality in education and oriented action performance [2].

The strategic structure and functioning of educational institutions is very important in the twenty-first century in terms of creating human profile [3]. Individuals who learn focus on learning. In the twenty-first century, knowledge and ethics play an important role on human nature, so it is needed to adopt creative thinking, flexible thinking and peace to the individuals. It is unavoidable to have an education system, of the individual in peace with himself, with life and world, and have a vision of giving importance to the values. It is needed to increase the security of the school environment, form contents for the recovery of education in peace for the development of a self-confident generation by facing technology. The education system of today emerges as an important question mark in terms of how much positive contribution it gives to the child's both psychological and social development under the framework of school education. The presence of technology and informatics in daily and educational life could affect negatively, both psychological and social development of the learner. Also, the necessity of implementation of social interactions brings together a value and peace to the education process [4].

A school environment must be managed securely as much as having a secure environment, and all the management stakeholders must communicate correctly with each other. In this context, it is expected to reflect today's administrative efficiency features of school teachers and administrators for correct performance [5].

It is also needed for administrative efficiencies, emotional strength, performance and technology, and when required, strategic steps must be taken for a sustainable positive image of the institution. To achieve this, a school culture must be created to provide its sustainable structure [6]. To form a school culture, visible and invisible institution sizes must be well known by all the school staff and stakeholders and needed to be internalized.

Institutions must do the internal and external audit processes to see how it is perceived from outside, such as symbols and logos in visible and rituals in invisible sizes, which are important elements to affect the continuity of the institution culture [7, 8]. At the point of invisible sizes, institutions must increase their sharings in a consensus to ensure the continuity of the image to prevent conflict management by using empathy educations [9, 10].

Quality becomes a milestone for enhancing learning and teaching practices through contemporary standards. Quality provides insights on enhancing standards of education to adopt transformation. In this respect, transformation is crucial. It is referred as an alteration, act and process to revamp the existing situation. Therefore, transformation in education is facilitated by the impact of the information and communication technologies. It is noticed that information and communication technologies play a great role to acquire changes in an education

http://dx.doi.org/10.5772/65221

system. As schools are small units, as an example of organizations, digitalization of learning and teaching activities become intensified to accomplish transformation in education.

Information Communication Technology (ICT) has an impact on global economy, people's lives, as well as on the education system, especially in schools. The way of managing schools and the ways of learning and teaching have changed. In this respect, education becomes in transformation through digitalization. The use of new technologies change the way of school management and culture. In this respect, knowledge creation, learning and innovation become the milestone through support of digitalization in school management and culture. This puts an emphasis on establishing transformation in education, especially in school management. Digital based learning, teaching and leadership gain importance to facilitate contemporary standards in learning and teaching practices for the quality [11]. ICT has a social impact that makes headmasters and parties in schools to enhance school culture based on digitalization in knowledge creation. In this regard, it is essential to question the culture of schools and their management within the process of adaptation to digital transformation.

1.1. Technology and education in North Cyprus

The education system in North Cyprus has a centralized management policy in which educational policies and strategies are decided by the government. There is a pre-school, secondary school, high school and higher education system. Education is compulsory until high schools. All schools are connected to a central authority. The headmasters are responsible for the management and following the rules of the central authority [12].

The Cyprus Turkish Education System aims at educating people to do researches, to question and think scientifically through the ability of communication they gain within 14 years. The new education system relies on basic education, secondary education and higher education. Pre-school education starts at the ages of 4–5 and it basically covers games until the ages of 5–6. Compulsory education starts at the age of 6 until 13. The first semester starts on 1 September and ends on 30 June. There is a break in February. Classes start at 7:55 in the morning and end at 12:00. There are six lessons and two breaks during the day. Classes in secondary schools end at 13:00. Twice a week, there are social activities in the afternoons.

The headmasters are responsible for implementing the rules and regulations of the Ministry of Education. Their main responsibilities are:

- coordinating school management
- knowledge management
- motivating and controlling the teachers and the other school staff
- coordinating teaching learning activities and school activities
- managing collaboration and resources

It is the responsibility of the headmasters to manage resources and follow new trends in education. Therefore, technological resources are set by teachers and headmasters. This shows how innovative they are to be digital leaders in school management to foster quality-oriented school culture.

In this respect, considering the outcomes of transformation is essential. School management is an umbrella of facilitating learning and teaching. Therefore, the role of digital transformation in school management is an intensified need to be underlined. In establishing school culture, school management plays an essential role that digital transformation affects the school management and culture for the quality in education.

Primary education institutions are taking steps in terms of improving organizational structures in a quality framework with strategic structure and functioning of the learning cycle. At the path of quality, it is important to create theoretical and applied frame for enrichment of strategic structure and progress by evaluating the culture of the institution. At this point, the symbols, rituals and values belonging to the institution give information about the vision and function of the institution. Also, they draw attention to create future quality steps.

This research aims at finding out the importance of technology and the evaluation of the functionality of symbols, rituals and values at the rural area educational institutions. In this research, the data was gathered by using an interview technique, based on qualitative research design. The descriptive analysis focused on the functionality of the existing symbols, values, rituals, roles and responsibilities of the school administrators and teachers for the improvement of the functionality of symbols and rituals through technology use.

2. Methodology

This research has a qualitative nature. Reflective reports of headmasters were gathered as data to understand the readability and awareness of school management to digital transformation in North Cyprus. In addition, a content analysis was done to realize the upcoming issues in school management and digital transformation.

A snowball sampling technique was used to set the survey group [13]. Because the best data could be gathered from the rural area school administrators and teachers, it was believed that the sampling technique was relevant to the aim of the survey. This survey was carried out with 10 school administrators and 50 teachers from 3 rural area schools in North Cyprus.

2.1. Data collection procedure

The data was collected between 23 February and 15 April, 2016, when all the participants were available. The date was collected through a 40-minute face-to-face interview with the school administrators and teachers of three rural area schools with the aim of surveying the situation of symbols, values and rituals. To gather richer data from the interviews, a comfortable and relaxing environment was created.

2.2. Data collection

On the interview form, the questions were prepared to define the exact perceptions of the teachers and school administrators of the three schools about symbols, rituals and values. For

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the validity of the interview form, three experts examined the questions. Because of some similarities in contents, some of the questions were removed and some were combined. Also, the intelligibility of some questions was improved and the final version of the interview form was set. Two school administrators and three teachers were chosen, and a pilot interview was given to assess the clarity of the questions and the appropriateness of the answers. The recorded answers were put into written form as an interview documentation. Later, two other experts examined the documentation for clarity. There was a 91% agreement between the two experts. At the end of the survey, the validity of the questions was approved and the process of collecting data started.

In this survey a four-phase content analysis was done.

2.3. Coding the data

During the interviews, the recorded data was analysed and each row was numbered by giving a number to each row and an interview dump was formed. Following this, the documents and cassettes were examined by an expert for clarity and correctness. The collected data was examined and divided into significant meaningful parts and coded by significant supplementaries in itself. After coding the data, a code list, which was a key list, was created while processing the data. Later, the coding keys and documentations were read by the participants, agreements and disagreements were discussed and the necessary arrangements were done. For the reliability calculation of the survey, the formula of reliability of [14] was used, and an 88% reliability rate was reached. A calculation rate of 70% or over is accepted as reliable [14].

2.4. Finding themes

In the phase of coding the data, the designated codes were collected in certain categories in order to create themes. In this survey, four dimensions were formed with school administrators and teachers of the three schools aiming at searching the situation of the values, rituals and symbols.

2.5. Organizing the data according to the themes and codes

In this phase, opinions of the participants were explained in a clear language and were presented to the reader from the first hand. Dipnotes were used in order to identify which opinion belonged to which participant. An example to the coding system is provided below.

Example 1…………………(T1)

T: Candidate Teacher

A: School Administrators

3. Findings and conclusion

3.1. Findings

The findings from three primary schools are presented below. Mathematical analysis method was used in order to make the findings reliable, to lessen the bias and to make it possible to allow comparisons between the different topics and categories that came into view. Therefore in the research, findings were presented in percentage in tables. The opinions and ideas of the participants were also presented as much as possible.

3.1.1. Function of the symbols, values and rituals in education establishment

The first part of the research dealt with the functioning and findings of the symbols, values and rituals. Under this heading, in order to find out about the functioning of the symbols, rituals and values in an education establishment, questions were asked to 10 school administrators and teachers. Their thoughts are presented in **Table 2**.

Participants	School administrators	Teacher	Total
School 1	2	6	8
School 2	5	26	31
School 3	3	18	21
Total	10	50	60

Table 1. Demographic Information.

Referring to symbols, values and rituals in an education establishment, 40% of the participating school administrators said their function should be to make the children love their country, their citizens and their environment. The teachers expressed by a 43% consensus saying it increases the children's nationalistic emotions. These two categories seemed to be the highest amongst all the others in **Table 1**.

Therefore, these findings showed that the school administrators and the teachers, all agreed on the symbols, values and rituals functioning in a positive way to make the children love their country, to love its inhabitants and their surroundings. Moreover, it is stated that the symbols, values and rituals made the children to adapt to their surroundings better in the future, to be more in harmony in their community and also to increase their nationalistic favour and to transfer the cultural heritage to the future generations.

School administrators expressed their views as such 'We, in our schools always organize ceremonies on meaningful, historical days, and perform many activities with the children to keep them about loving their country, their citizens and their environment'. Also, a teacher expressed his views related to these topics as such 'I consider my students' development to love their flag and to be nationalists very important. Every morning in the classroom, I talk to

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them about the important days from our historical past and religious days. I want their nationalism to develop and take root in their minds' (T:35).

Themes	School administrators		Percentage	Teacher		Percentage
	Stating opinion	Not stating opinion		Stating opinion	Not stating opinion	
Culture of community to be transferred to future generations	2	8	20%	5	45	10%
Children's adaption to be in harmony in the futurein his surroundings	3	7	30%	6	44	12%
Children's love for their country, their surroundings and tied to these aims by heart	4	6	40%	18	32	36%
Continually increasing children nationalistic favour	1	9	10%	21	29	43%

Table 2. The functions of the symbols, values and rituals in the education establishment.

3.1.2. The increase in the symbols, values and rituals and the school administrators' duty and responsibilities

The second part of the research dealt with the aim to find the role of school administrators in the increase in symbols, values and rituals. The participants' opinions and thoughts are given in **Table 3**.

Referring to the functions of the symbols, values and rituals, 50% of the school administrators said that the preparation of the symbols, values and rituals, which has an important role in the history of the nation, should not be organized or prepared haphazardly. A total of 48% of the teachers said that the message should be given to the students through the symbols, values and rituals supported by different activities. These two topics seemed to be the highest amongst the others. In consequence, school administrators and teachers agreed that those symbols, values and rituals which occupied important meaning in the past for all the country and community should be prepared seriously not haphazardly. Besides the message to the students, symbols, values and rituals ought to be supported by different activities.

Furthermore, school administrators should be more hard working and spend more time to explain to the students the values, symbols and rituals to make them take those symbols, values and rituals as examples. These are the school administrators' duties and responsibilities. In order to strengthen the values, symbols and rituals, to root in the students psyche, more social activities and cultural trips must be organized.

A school administrator, with regard to the increase in the functioning of the symbols, values and rituals as a topic, expressed his opinion as such 'It is my duty and responsibility as a school administrator to be very serious and careful in preparation of those symbols, values and rituals which have historical roots and have a very important place in the community' (A:6). A teacher stated his/her opinion as such 'It is the duty of the school administrators to support the message they wish to give the students through the symbols, values and rituals by using different activities'.

Themes	School administrators		Percentage	Teacher	
	Stating opinion	Not stating opinion		Stating opinion	Not stating opinion
The symbols, values and rituals that occupy an important place in the history of the community	5	5	50%	12	38
Topics and messages wished to be given to the students through the symbols, values and rituals to be supported by different activities	2	8	20%	24	26
Explaining the meaning and importance of the values, symbols and rituals to the students and the message wished to be given	2	8	20%	8	42
Organizing more social activities and cultural trips in order to strengthen the meaning of the rituals, values and symbols	1	9	10%	6	44

Table 3. Increase in the functioning of the symbols, values and rituals, and the duty and responsibilities of the school administrators.

3.1.3. Determining the person to take part in increasing the functionality of the values, symbols and rituals

The third part of the survey was done to determine the person to take responsibility for the increase in the functioning of the values, symbols and rituals. In **Table 4**, the opinions, topics and given percentage are categorized and presented.

Themes	School administrators		Teacher	
	Stating opinion	Not stating opinion	Stating opinion	Not stating opinion
School administrators, class, and branch teachers taking responsibility and duty	6	4		
Local authorities and civil/public organizations to take part in the increasein the symbols, values and rituals	3	7		
Parents' and associations' responsibilities and duties	1	9		

Table 4. Determining the responsible person to take part in the increase in the functioning of the symbols, values and rituals.

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In determining the person to take part in increasing the functioning of the symbols, values and rituals, 60% of school administrators stated that 'school administrators, class teachers and branch teachers should take part'. Thematic findings showed that for the increase in the symbols, values and rituals, especially local authorities and civil public groups should take responsibility and duties besides the increase in the responsibility and duty of the local authorities and civil public groups. Even more, families' and parents associations' role should also be increased.

For the increase in the functioning of the symbols, values and rituals, a school administrator presented his idea as, 'In order to increase the worth of the symbols, values and rituals, the message we wish to give to our students, it is vital and can easily be said that school administrators, class and branch teachers have to work diligently very hard'.

A teacher said that local authorities and civil public organizations must also take a leading role to increase the functioning of the symbols, values and rituals.

3.1.4. Using technology to increase the worth of values, symbols and rituals

While using the symbols, values and rituals, 50% of the participating school administrators and 48% of the teachers stated that in the transfer of the symbols, values and rituals, with the use of technology, they should increase using visual materials and effective films. Also, 40% of the participating school administrators and 34% of the teachers, for implementing the worth of the symbols, values and rituals, insisted on more technology, such as social media and Internet, more social activities and more cultural trips. It is understood that those two themes are the highest amongst all. In this phase, school administrators and teachers use technology on using symbols, values and rituals. Also, it can be said that to make the meaning of the values, rituals and symbols on children, more powerful cultural trips and social events are needed to use technology more effectively. A school administrator, with regards to the use of technology in transferring symbols, values and rituals, stated his/her belief as, 'I am trying to make more use of the technology in transferring the symbols, values and rituals to my students' (A:10).

Another teacher stated a belief as such 'What I wish is to give my students are effective indoors and outdoor activities to do with symbols, values and rituals through social media and Internet'.

3.2. Conclusion

In this study, the results and suggestions obtained from the primary schools, school administrators and teachers of rural areas, analysing symbols, values and rituals, are stated under four headings as below.

In reference to the functioning of the symbols, values and rituals in education establishment, the school administrators stated, '40% of the children's aim is to love their country, their surroundings and to be tied to these aims by heart'. The teachers stated, '43% of the children's national emotions topped up'. Therefore, by referring to this survey, the school administrators and school teachers stated that the symbols, values and rituals that are present in their schools contributed to their country, surroundings and their citizens. In addition to these, the present symbols, values and rituals by their functioning helped children to be in harmony within their surroundings as well as increase their responsibility for the community they live in.

These findings [9] show similarities with [10] work. However, in order to develop children's nationalistic emotions and the communities' cultural heritage, to be transferred to the next generations, more use must be made of the symbols, values and rituals.

In the functioning of the symbols, values and rituals, 50% of the school administrators stated that, 'Those symbols, values and rituals which have an important place in community, must be prepared seriously and due application'. Teachers stated their opinion as, 'The values, symbols and rituals, which constitute 48%, must be supported by different activities'. Therefore, school administrators and teachers in their schools must prepare those symbols, values and rituals very haphazardly. In addition, the message wished to be given to the students through the symbols, values and rituals by the school administrators must be supported. Our result is similar to their results. Unless we can advise more cultural trips and social activities to be organized in order to strengthen the meaning of the values, symbols and rituals on children.

A total of 60% school administrators, class and branch teachers should take part and responsibility in the increase and functioning of the symbols, values and rituals. A total of 56% of the teachers stated, 'local authorities and civil establishments should play a bigger role and duty'. These results show similarities with the results obtained by [4]. In addition to these, in order to increase the symbols, values and rituals' worth, larger duties and responsibilities are laid on student-parent associations and the families too.

Topics	**School administrators**		**Percentage**	**Teacher**	
	Stating opinion	**Not stating opinion**		**Stating opinion**	**Not stating opinion**
Use of technology, visual material, and effective films while using symbols, values and rituals	5	5	50%	24	6
Message wished to be given to the students through the symbols, values and rituals	4	6	40%	17	33
Explaining the importance and meaning of the symbols, rituals and values to the children in order to increase awareness	1	9	10%	9	41

Table 5. Role of technology and digitalization in school culture.

The fourth topic comprises of the contribution of technology, when using the symbols, values and rituals. Participating members' opinions and percentage are stated in **Table 5**. While using the symbols, values and rituals, 50% of the administrators and 48% of the teachers stated an opinion that while benefiting from technology, they should use visual materials and effective films. Also, through symbols, values and rituals, the messages wished to be given to the

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students are to make more use of technology to be more effective. Social media and Internet activities, indoors and outdoors, were supported by 40% of the school administrators and 34% of the teachers. These two topics seem to be the highest amongst all the others. In this respect, the participants stated the effective use of technology, films and Internet in schools to transfer the symbols, values and rituals to their students in a more effective way. They also pointed out that the use of technology should be furthermore increased especially in and out of schools. Symbols, rituals and values wished to be taught to students in an effective way, those activities that are done in and out of school premises should be publicized through social media, Internet and all the technological means in hand.

These findings show similarities with the findings obtained by studies [1, 2]. Besides strengthening symbols, values and rituals in the students, more social activities and cultural trips should be organized, and these social activities and trips should be recorded by using technology to be shown to student at later stages.

As this focus is demanding for developing countries, especially North Cyprus, the research in this chapter revealed that headmasters are aware of the use of digital and technological facilities in schools. They are aware of digital transformation although there are restrictions, both in application and budget.

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Chapter 4

Usage of 3D Computer Modelling in Learning Engineering Graphics

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Misa Stojicevic

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65217

Abstract

What is graphic communication? Firstly, it is a very effective way of communication between the technical idea and the final solution of the problem in engineering. The process engineering design (design) begins with visualization, i.e., reviewing the problem and possible solutions. Then, sketching leads to the preparation of the initial idea. Next step is preparation of geometric models, which are used for a variety of engineering analysis and, finally, creating detailed drawings and/or 3D models, which are used for the production process. Visualization, sketching, modelling and preparation of technical documentation are ways in which engineers and technologists communicate in creating new products and structures in the modern technical world. Essentially, graphic communication, which is done via engineering drawings and models, is the clean, practical language with defined rules that need to be overcome if one wants to be successful in engineering design (any kind of design). When that language can overcome any approach to solving engineering problems. Ninety-two percent of the engineering design process is based on the graphic display. The remaining 8% is divided between the mathematical calculations and written and oral communication. Fifty percent of the projecting time a designer spends on are purely visual and graphic activities. We like precision in communication. Engineers use graphical tools, some of which are centuries old and are used day-to-day, while others are very new and conditioned by the rapid development of computer technology, such as Computer Aided Design (CAD) systems. From this chapter, users will be able to familiarize themselves with the above tools and principles of their use.

Keywords: graphics communication, freehand sketching technical drawings, 3D model, 3D modeling, communication process

1. Introduction

Three-dimensional modelling is a modern approach to the development of technical graphics systems. Engineering graphics and 3D solid modelling, the two basic methods of design underrepresented in use today, are shown in **Figure 1**. The engineering graphics in the form of multipurpose technical drawings (top left) is a method of design that is used for almost two centuries. Modern design methodology tends to the greater representation of computer technology, and the design process is focused on the preparation, analysis and construction of three-dimensional geometric model (bottom right). Although shaded, display model on the screen looks impressive, but the real power of this method is precise and unambiguous description of the object that contains all the data stored in the computer. During the process of preparing a given work, all the data are stored in memory of the computer and can be used by other customers in the supply chain, for example, preparation for engineering, manufacturing, analysis, documentation and manufacturing drawings.

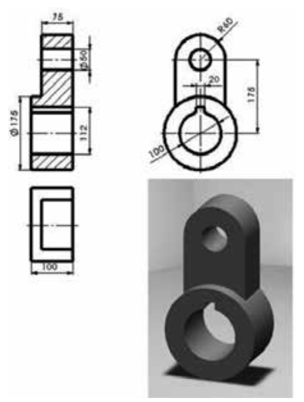

Figure 1. Technical drawing and 3D solid model.

Modern development of technical systems cannot be possible without the use of this type of graphic expression. A detailed description of the methods and principles of 3D modelling is given below.

2. Engineering graphic communications

Communication between people takes place polyvalent: through language, written text, symbols or graphics, or people say, write or draw.

Many primitive societies have not progressed to the level of the permanent record. All communications in much of the history were conducted orally. Oral expression is the first form of human communication with the environment. Children are taught voice expressing before the age of 2 years.

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During training, acquire the ability to communicate in writing. Thus acquire the ability to read and write is the most widely used mode of communication. The skill of communication through symbols infiltrates in this area of communication fully.

The graphics are also very important form of communication. All graphic forms are very important for communication among engineers in all fields of technology.

Engineering graphics is the language used by engineers to transfer ideas and information needed for the construction of technical devices and systems. This language includes drawings, sketches, plans, schedules, diagrams, notes and instructions. Graphics in Engineering has three main objectives, namely:

- Analysis and display structures
- Transfer of information on the structure
- Record of the development and construction of replacement in it

Engineering graphics includes formal and informal drawings, sketches, all diagrams and plans, and sometimes non-physical relationships of ideas, if these relations can be graphically displayed.

Engineers are constantly using informal drawing or sketching—"talking pen and paper," and generally, this type of communication crossed without classical training. Throughout history, particularly in recent times, and resulting from technological advances in the field of computer graphics and computer, this type of communication is gaining in importance. The idea is given in the form of freehand sketching; a complete process projecting was carried out through computers and 3D software.

Engineering graphics is a bridge which ideas are translated into reality. It is hard to imagine a modern society without that, moreover, a large part of modern industry would not have occurred or would cease to exist.

3. Technical sketch

Sketching is the simplest form of engineering drawings. It is used to quickly develop ideas and transferred to others. Good sketch should contain three basic characteristics as: quickly prepared, simple and easy to interpret. Nothing is needed for sketching except a pen and paper. When performed without a prop called freehand sketching, polished and more formalized sketch station technical drawing, which is quite different and used for other purposes. It is important to distinguish between these two activities. Exercise should develop skills and techniques of sketching, and making of polished technical drawing if necessary. Otherwise, trimming the drawing would be a waste of precious time.

In addition to making it possible to convey the idea of another, sketching is a great method of communicating with itself. Sketch supports thinking can improve memory or to facilitate the clarification of the spatial situation. The pencil and paper can be very useful during the development of physical or spatial concept (**Figure 2**).

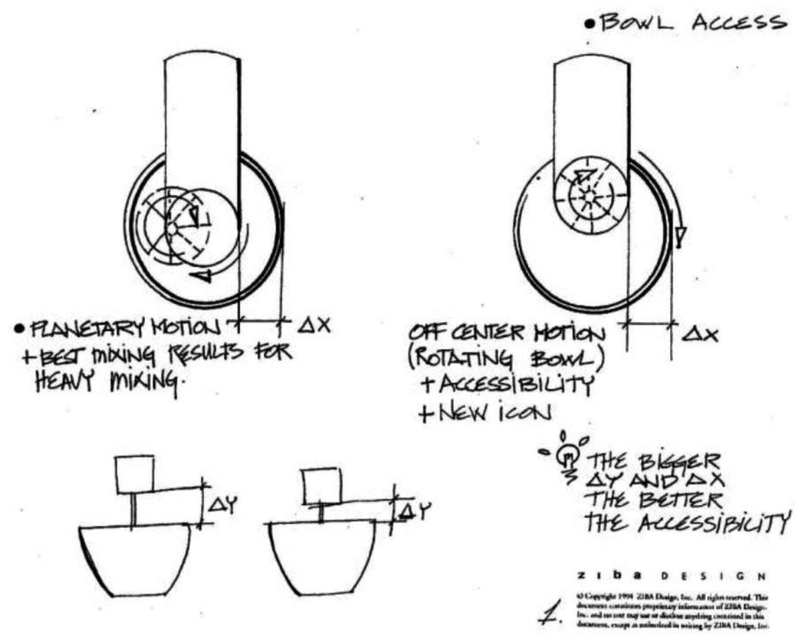

Figure 2. Technical sketches (Ziba design).

Freehand sketching is one of the oldest forms of, if not the oldest form of expression of engineering ideas. The knowledge that we gain from that field is used during the entire engineering work. This form of expression is resistant to the technological development of the system for technical drawing and graphic expression of technical systems. It exists and is not visible when the final time limit would cease to exist independently of the principles of graphic communication. An example of freehand sketching of mechanical part is shown in **Figure 3**.

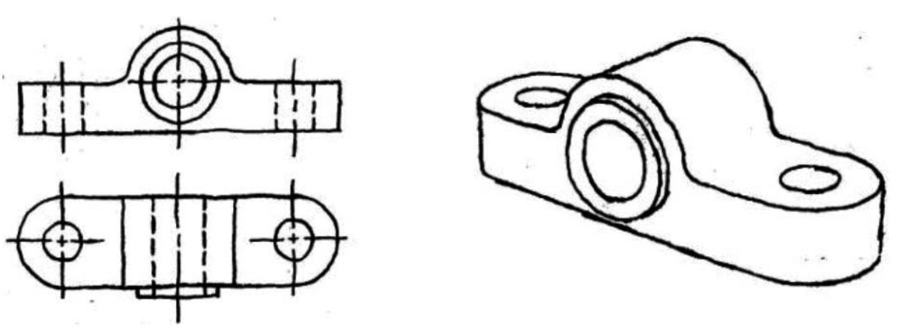

Figure 3. Sketch of 2D drawing and 3D model.

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This fact has been proven in a number of leading world universities. The basic philosophy of the new approach graphic communications lies in the realization that modelling of the body serves as a starting point for the presentation of the technical system, visualization, stress analysis and production of parts, and finally to the formation of technical documentation. According to this philosophy of training, end-users must contain in itself the power freehand sketching was carried out in four stages:

1. Sketching, to facilitate mastery of 2D designing, which in turn present the basis for the design of a 3D model of the technical system.
2. Spatial sketching, which helps train for geometric modelling of the technical system on your computer.
3. Sketching projection with sections and dimensions in preparation of technical documentation based on 3D models.
4. Reconstruction of some parts of the technical system captures parts of the system, sketching and reversible technical documentation.

4. Technical drawings

Technical drawings are graphical representations on which they are made machines, structures, components and technical systems. They include:

- Detailed drawings, showing components, material of which should be made, their dimensions and other information (e.g. who designed, approved, when it was designed, etc.).
- Switchgear drawings, which show the manner in which the components are assembled.
- Spatial drawings or perspective view of a facility.

The process of communicating technical and scientific ideas and concepts implemented in such a way that leaves little room for error. This "language" contains a lot of generally accepted procedures, rules and methods, that users study and use.

Technical drawing is based on the principles of descriptive geometry, or the design for displaying spatial element in the level of drawings, all in combination with the regulations, which were formalized national and international standards to simplify, simplify, and to adapt the technique of this preview. Technical drawing is not artistic drawing and of itself is a special discipline that has its own logic, however, if such can be taught and learned.

5. Visualization cycle

A very powerful tool in the engineering and design work is the ability to imagine a solution to a problem. Visualization is the ability to form mental images some objects that are essentially non-existent. Engineers and designers have a highly developed ability to plant a mental image, but also that the “control”, that is observed from various sides, changing shape, look inside, to move some of its parts and manipulate imaginary object.

For effective use of graphics as a tool for visualization of design ideas, it is necessary to understand the two-dimensional graphics, the user draws on paper or computer screen, and the display of visual information in another form. Previously, enumerated drawing techniques that may be used for this purpose, the user draws what sees, and this is a direct link between what is seen and what is displayed (**Figure 4**).

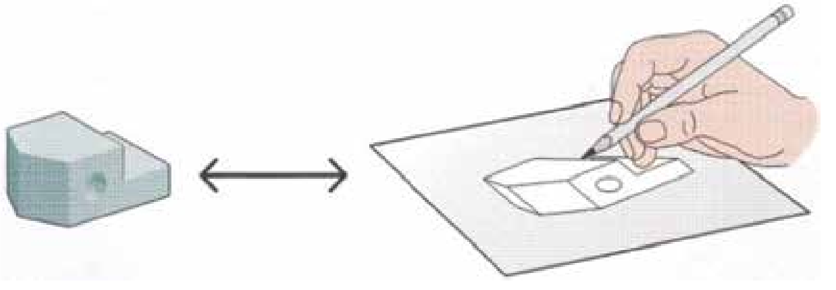

Figure 4. Interaction hand/eye [1].

Mind processes and interprets visual information and controls muscles that hold a pencil (**Figure 5**). As a 3D object, a drawing that is formed on the paper can be seen and serve to make organizations and focus the image in the mind of the user. Thus, creating a loop transfer form between the mind, the level/pencils and drawing, which allows realize the idea of 3D objects. In other words, the image in the mind can be formed without the aid of a real object. Now sketch an even more important role, because the real subject is not in the field of view (or perhaps even the idea) and the sketch becomes the sole record of the object. The eyes and the mind, seeing the sketch, can begin modification and development facility, new drawings can be made, and the whole cycle can be starting again. This is only visualization cycle.

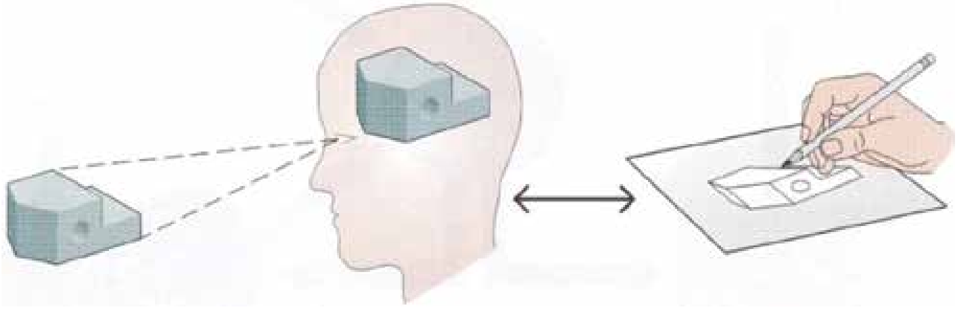

Figure 5. Interaction hand/eye/mind [1].

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Visualization is an important and integral part of the engineering design process. Whether you are using a computer or a classic tool for technical drawing, engineers and technologists must have the ability to document their design ideas, on the basis of well-defined technical graphics standards. They must also have the ability to understand at a deep level, three-dimensional forms and their documentation.

The ability to visualize shapes in mind enhances the ability of users to understand how existing facilities, and facilities that have not yet been incurred. Visualization of three-dimensional shape allows the playing of the "what if" in the early stages of the design process, before forming the physical models. It also allows the ability to visualize and detailed spatial analysis of the occurrence of any problems.

Engineer or technologist should be professionally involved in solving the problem. For most problems, it is necessary to ask some basic questions:

- What information is available?
- If it comes to graphic information, in which form (planar drawing, photography, computer rendering, etc.)?
- What are the questions to be answered?
- Is there sufficient information (graphic or otherwise) to answer these questions?
- If there is not enough information, where to find them?

In most cases, there is not enough information. In this case, consult external sources or inventing new ideas. The information can also be generated from previous knowledge. For most of the problems with video information that is the best way. If there is not enough graphical information is necessary to immediately start drawing what is known. Now begins the game of "what if" in which everything has a mental picture, but there is large number of ideas that are difficult to keep in mind. They are at the paper (or computer) and moving idealization process of admission and the process of rapid generalized ideas that are developed in the mind.

How ideas are developed drawings are becoming more formal. The formality is necessary for communication with other users.

This process is very similar and in developing ideas into three-dimensional space. Tools are different, but the idea of the formation of the design is the same. When you gather all that is known about the mental construction and the result of drawing/modelling, it is possible to visualize a 3D object and continue to develop.

6. Graphical methods of technical systems modelling

Engineering design show [2] is a collection of tools that help designers and developers to visually project and spatially prepare preliminary designs, and also that these solutions are checked and displayed to others. During the examination of designs, when a designer/developer combines, compares, processing and preparation of examination of all data and conceptual solutions mainly used freehand sketching tool.

Simplify, the development phase of this process involves defining ideas in two phases: research and development. In the development phase, the researcher translates your ideas from the research phase of the use of computer tools (or, as the case was before, when was in use graphic communication tools of engineering and technical drawings and the like.) in a final feasibility study, used to further communication in the framework of the preparation of the final product. In recent years, conceptual phase is mainly based on freehand sketch, a development on the application of a software tools and computer geometric modelling (**Figure 6**).

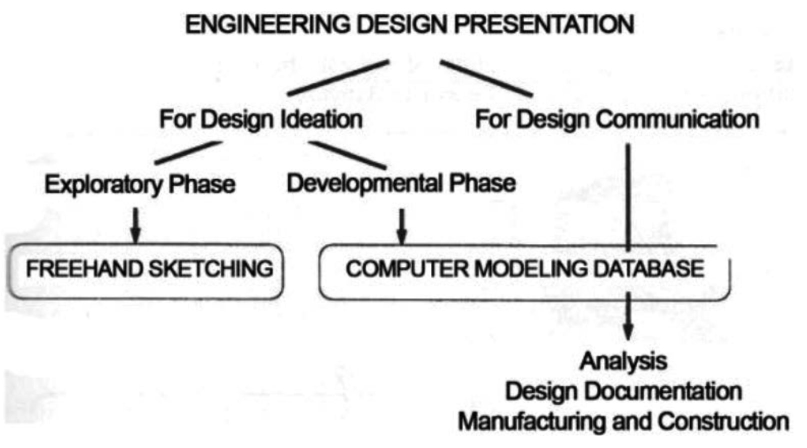

Figure 6. Engineering design presentations [2].

7. Modelling, models and technical systems

Modelling is the process of presenting abstract ideas, words and shapes, through the proper use of the simplified text and image [4]. Engineers use models for thinking, visual, communication, prediction, control and training. The models are classified into two categories: realty could be shown on the descriptive or predictive way.

Descriptive model represent abstract ideas, products or processes in a recognizable form. An example of a descriptive model can be the engineering drawing or a 3D computer model of the mechanical part (**Figure 7**). Drawing or model serves as a communication tool, but they cannot be used to predict the behaviour or performance obtaining technical elements/systems. The predictive model is one that can be used to understand and predict the behaviour/performance design solutions, products or processes. For example, predictive finite element model is a model Cantilever, which is used to predict the mechanical behaviour of the cantilever under the given loads.

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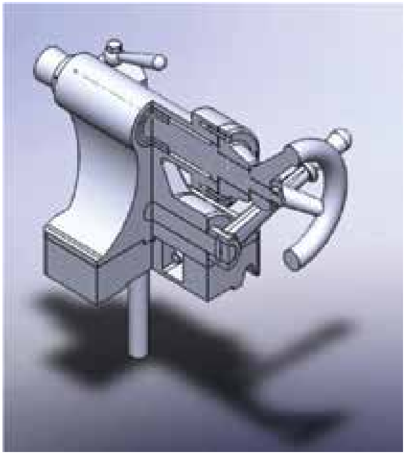

Figure 7. Descriptive model [5].

During the preparation of the final product, it is possible to use two types of models: mathematical models and physics models-layouts. The mathematical model is a set of mathematical equations that represent parts of the system. **Figure 8** is an example of the mathematical model used to predict the loss of power of thrust bearings while increasing speed.

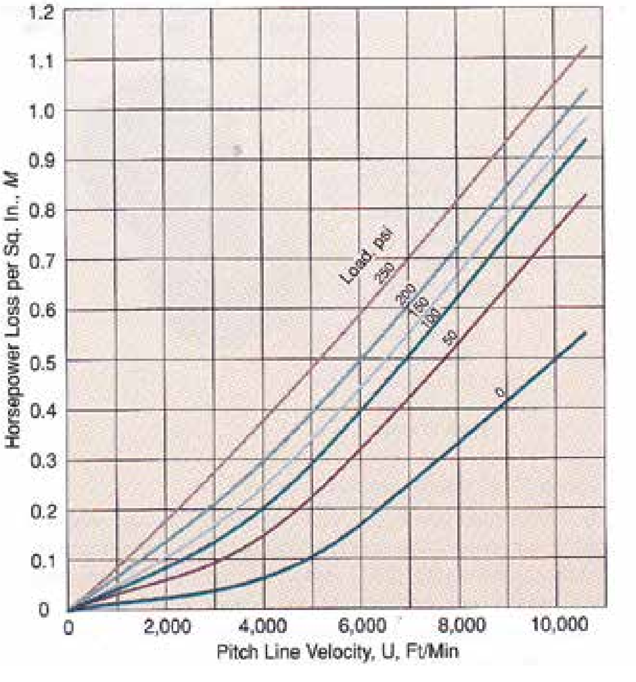

Figure 8. Predictive model (example of a mathematical model; Machinery's Handbook, 25th edition).

The model is a physical model developed in a way that most faithfully represents the parts of a system. Model may be full size or replicas made in the required (preferably standard) scale. Before the advent of computer 3D geometric modelling, physical models are made of clay, wood, foam or other materials.

The rapid development of computer modelling caused rapid preparation of prototypes and reduces the need for creation model physically, which relied on traditional techniques. This phenomenon is called “rapid prototyping” and represents a wide spectrum of operations, which are used to describe several related processes, relying on real models that are taken directly from 3D CAD data base. As defined above, this process can drastically reduce the time between the development of a concept model and making the projected work.

Geometric modelling is a set of processes of complex ideas, products or processes, using drawings or computer models instead of conventional in design process. The final drawings, received using this method were created as 2D and 3D schemes or models. Two-dimensional schemes are very useful for some engineering analysis, such as kinematic, and check the position of circuit elements, wiring diagrams and check the blueprints, schematic view of some components and structural plans.

Three-dimensional models are created in the CAD system may be in the form of a “wireframe” model, surface or solid models. “Wireframe” models are used as input geometry data for easy analysis of the work, such as various kinematic studies and finite element analysis. Surface models are used in visualization; automatically remove hidden lines and animation. Solid models are used for analysis and visualization of the mall together with engineering and math, and they are most precise product descriptions and facilities.

8. 3D modelling

Traditionally, communication between engineers was performed through drawings, which can be in any of the aforementioned forms (sketch, drawing, physical model). In recent years, caused by a rapid technological development in the field of computer technology, 3D solid models have become available in all forms of communication engineering and take a leading role in all aspects of engineering. There are two basic approaches to generating 3D solid model:

- Wireframe model.
- Surface model.

The simplest form of the formation of the 3D modeller is wireframe modeller. In this type of modeller, use the two elements that must be defined essentially: edges and vertices (**Figure 9**). For the tetrahedron, shown in **Figure 5**, the vertex list contains geometric data.

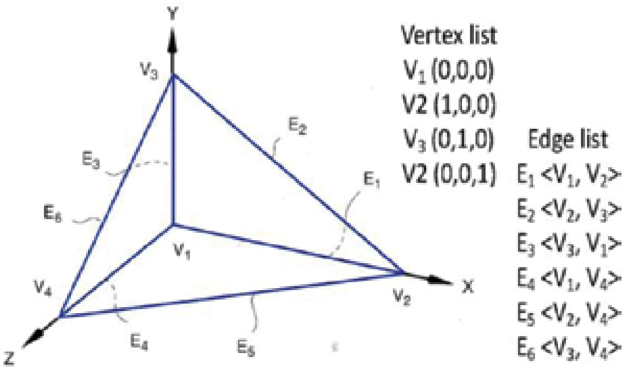

Figure 9. Wireframe model.

Wireframe model may also contain information on planes, such as the size of the location and orientation just as the edge defined by the vertices coordinates, levels are defined by three or more edges. However, all this information is related only to a set of edges. There is no possibility to join the space between them.

During modelling, wireframe model, in most cases, should include a combination of curves and straight edges (**Figure 10**). In this case, they display "wireframe" model of the cylinder. Complete circuit base is split into two arcs; it would be possible to connect it with the rest of the edges.

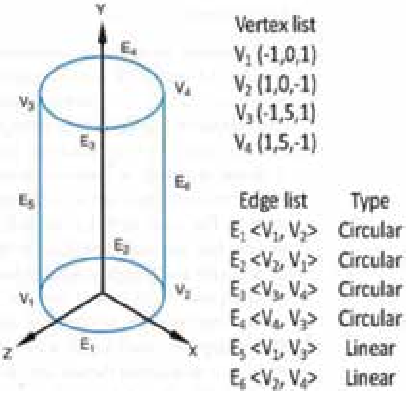

Figure 10. A wireframe model using circular and linear.

Wireframe model may have a problem of uniqueness. **Figure 11** shows an example of different solutions, respectively, different realistic looking surfaces with a unique wireframe model. Because surface information is not available, edges that would normally be hidden are not, and the orientation is unclear. Some wireframe models have implemented computation routines to calculate and remove hidden edges. Since this involves calculating surface information that is not inherent in a true wireframe modeller, the process is often slow and cumbersome.

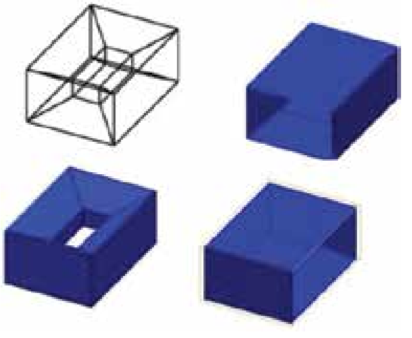

Figure 11. Lacking wireframe model.

Surface model defines both the characteristics of the surface and edges of a geometric object. Surfaces can be formed using several different techniques. Some of the most popular techniques are as follows: buckling, reversal and creating compounds ripple limit curves or sets of points (clouds of points).

Sweeping is a modelling technique in which the surface is obtained by movement Directrix through Generatrix (**Figure 12**). Directrix is a typical 2D line, while generating can be a line, curve or 3D planar fault.

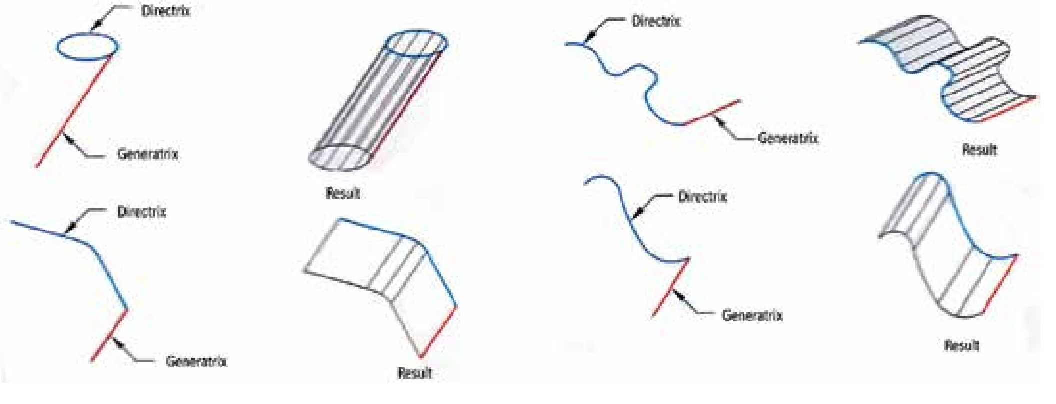

Figure 12. Swept surfaces.

This technique can be obtained for receiving complexes surfaces. **Figure 13** shows a Directrix curve being swept out along a curve Generatrix to create a surface model. An alternative to this technique is that the Directrix directly rotates around its axis. In this case, performs the function of axis Generatrixes. **Figure 14** shows a classic example of the surface obtained by rotation. In this case, the axis of revolution acts as the Generatrix. It is shown a classic revolved

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surface, a half circle revolved 360° to form a sphere. More complex forms can be created using techniques such as placing the axis of revolution so it does not touch the Directrix, using complex curve as a Directrix, and revolving less than 360°.

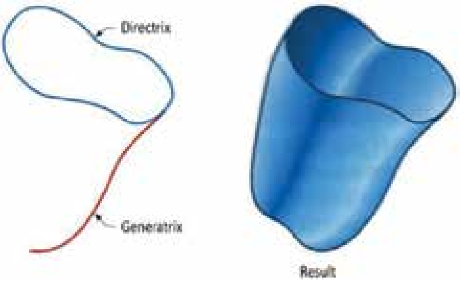

Figure 13. Complex surface.

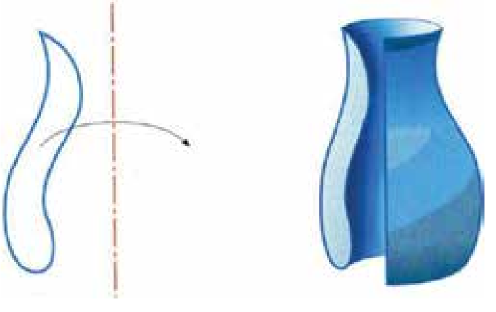

Figure 14. Revolved surface.

Using multiple Directrix to define multiple intermediate point, it can form even more complex surface. This technique, lofting, allows define critical changes in the shape in the Directrix along the vertex. Directrix is arranged in parallel or helically relative to one another within the required distance (**Figure 15**).

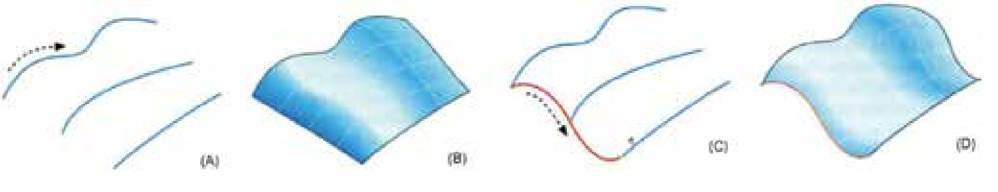

Figure 15. Lofting to define a surface.

It is also possible to use a freedom curves as regularly to create a surface patches from boundary curves.

9. Methods of computer graphics simulation, animation, and analysis of virtual 3D models

Computer simulation is a set of very precise modelled real situations that affect the technical systems in real time. Three-dimensional computer model can be used instead of physical to perform the necessary analysis. **Figure 16** shows the simulation of the heat exchanger. Regardless of the aesthetic moment, this analysis provides a very clear picture of the quality of the proposed design and its functionality. According to the colour palette, constructor can check their preliminary design directly to correct it, if necessary. This process does not require a large work time, and it can be repeated in a large-required number of iterations until a satisfactory solution. Simulations have substantively role in scientific studies of certain technical systems. They are very useful in a variety of presentations.

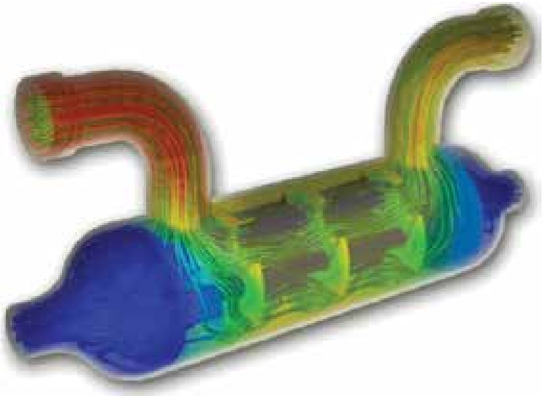

Figure 16. Simulation of the heat exchanger [1].

Computer animation is to show the behaviour of a system in real time. The difference between animation and simulation in the degree of precision of the results obtained, animation describes examination about the situation, while the simulation accurately describes. A lot of technical systems contain mechanisms with moving elements. The movement is achieved by moving the geometric space of time. These are very important elements of technical analysis of the design of the system. For visualization of the technical system's geometry is what it shows. For the mechanism, together with the movement must be displayed and the time dimension. One way to view the movement mechanism is to present several images of movement of technical systems in different time intervals. Using computer, time interval is easier to show and motion picture series fits into animation. The quality of the animation depends on the number of images (frames) in a time interval. The value of 15 frames per second gives the effect of the apparent movement of the body seems to be really moving. Combined with other items, such as the removal of invisible lines and shading, animation helps to clarify the shape and form of the building. In the event of a change of location and orientation of the animation, it shows successful change of geometry and shapes, such as deformation caused

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by the action of another object or removing material. Animation gives possibility to record changes and other more abstract data, not just the geometry.

Analysis of the design is the evaluation of the proposed design, based on the criteria established in the phase of creating the conceptual design. This is the second major step in the design process of the final product, and the entire design team is involved in it. Typical analyses are carried out during the design process are as follows:

- Structural analysis, which assesses the design basis of physical properties, such as strength, size, volume and centre of gravity, weight, and centre of rotation, as well as its thermal, fluid and mechanical properties.
- Mechanical analysis of the mechanisms dealing with the movement of the loads that can occur in the mechanical systems of rigid bodies-related joints.
- Functional analysis, which determines whether the proposed design for the way in which it is provided or whether the design performs and fulfil the requirements specified in the stage setting of the problem.
- Analysis of human factors (ergonomic analysis), which assesses the design to determine whether the product is used in physical, emotional, qualitative, mental and security needs of consumers.
- Aesthetic analysis, which assesses the design basis of its aesthetic qualities.
- Market analysis, which determines whether the design meets the needs of consumers, based on the results of surveys or focus groups.
- Financial analysis, which determines whether the price of the proposed designs to be projected range price range provided for in the idea stage.

Structural analysis is largely based on the analysis of the finite elements. Its task is to confirm the safety and longevity of use of the system. Models are tested in extreme conditions, and the information obtained is used to improve the technical solutions. **Figure 17** shows an example of structural analysis when designing presses for bending pipes. In this case, the analysis was performed voltage and deformations presses for bending during the process of exploitation. A large number of information helps the user to make a calculation of the forces acting on an object, but it is very difficult to determine how the building reacts to them. The virtual 3D model is designed so that it has the same thermal and elastic characteristics as the material of which will be made real product. Instead of the real load of articles model is load hypothetically using virtual 3D models and get the critical results of a physical prototype. Working with virtual model reduces the time of construction and production costs.

Mechanical analysis of the mechanisms dealing with the budget motion and loads of mechanical systems consisting of rigid bodies connected joints. One of most characteristic examples of such a system is a device for clamping. Mechanical analysis includes an analysis of a set of mechanisms, kinematic and dynamic analysis.

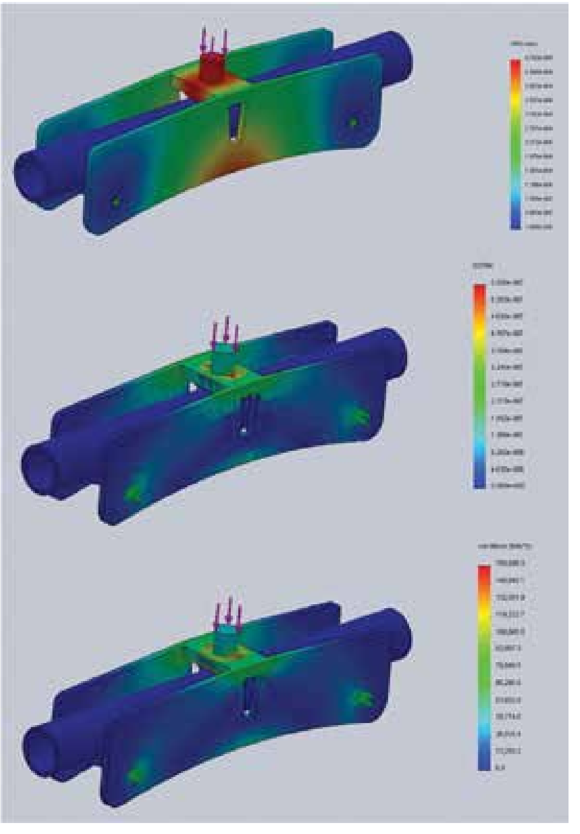

Figure 17. Analysis of presses for bending pipes [5].

Analysis of the core set is used to define the position of the individual solids and mechanism to verify correct installation, taking into account the geometry and speed of the circuit elements (**Figure 18**). When the computer 3D assembly dimensionally defined and assigned him the speed of the elements, the user types into a computer program complicated geometric and trigonometry relations.

Kinematic analysis is a technique used in the design of mechanisms, a set of several parts, which is run by defined legality. The mechanisms consist of two basic components: the body, which are associated levers and joints, which show that the leverage associated. The joint motion is carried, rotational, translational or a combination of the two. Connecting elements of the kinematic mechanism 3D model enables the designer to investigate fully and partially moving parts of the mechanism. This type of analysis also introduces a fourth dimension, time, 3D computer model. Time is determined by the orientation or location of a specific element of the mechanism in a certain period of time. The movement of parts of mechanisms can be shown transparently or by technique of moving with increasing "providence" display, and of course the animation. When this type of analysis, it is possible to check the geometry mechanisms so that there is no collision or overlapping elements. Although this analysis can be provided using

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visual operations, Boolean's cross-section (see at various time intervals topology and geometry of any overlap during movement mechanism) provides a more precise estimate.

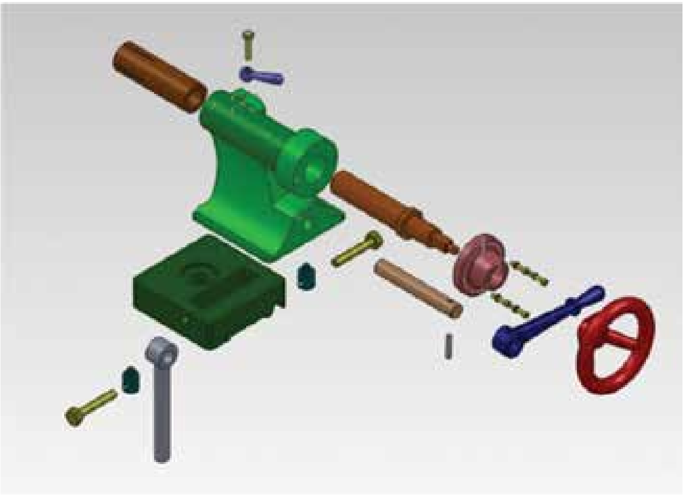

Figure 18. Assembly analysis [5].

Dynamic analysis is a sophisticated technique, which analyses the load under the influence of kinematic factors. Clean kinematic analysis predict that all parts moving at a constant speed, but without taking into account the forces acting on them. But the forces are acting on the mechanisms at any time. They are necessary in order to trigger a mechanism that would (due to friction) be continued to move. In these calculations, the most important role performed quality position of centres of mass of elements of the mechanism. This kind of analysis can be in the form of animation

Functional analysis is a process in which factors such as price, appearance, profitability, security, etc. had to take into consideration when determining the final design. Some factors are based on empirical evidence, such as testing for the ability to perform function, or as the fulfilment of the purposes for which it was designed.

Ergonomics represents a link between technology and man. It must include elements of comfort, efficiency and safety. It is possible to made 3D model products and man and to analyse their interaction. Some interactions are associated with the physical characteristics of the human body (**Figure 19(a)**), which are variable according to the value of personal characteristics. In the analyses, we use the mean value of the physical characteristics of the human population of a specific geographic region. Ergonomic analysis was performed in relation to the physical dimensions of the complete man. In **Figure 19(b)**, it shows an example of ergonomic analysis. In the case of ergonomic analysis of 3D models, it can be manipulated, introduced mimicry, movement, etc. or to perform animation. Human limbs in these simulations can be treated as parts of the mechanism. Other elements of the virtual environment must be in accordance with human dimensions.

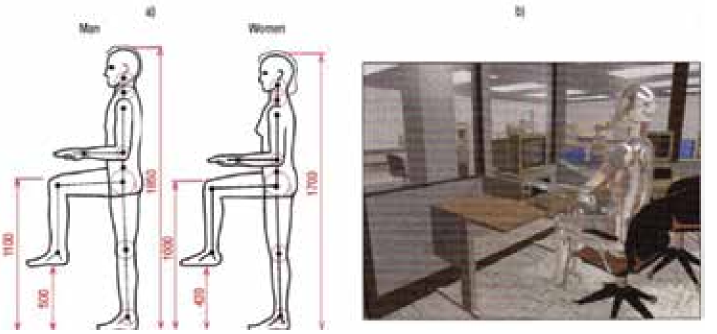

Figure 19. Ergonomic analysis.

10. Preparation of virtual 3D models of various technical systems methodology-formation model

Solid model is a set of volume and surface information from that form a 3D model. Most models can be described mathematically, using basic geometric shapes (**Figure 20**): a prism (with a specific case cube), pyramid, sphere, cone, torus (ring) and roller. Combining and subtracting these forms are obtained by more complicated models of different technical systems.

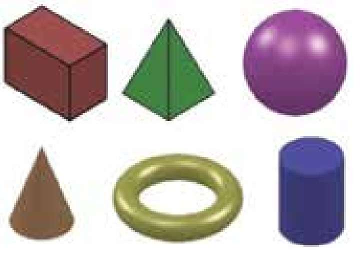

Figure 20. Basic geometric shapes [3].

To make virtual 3D model functioned properly in further analysis, it is necessary to properly form the initial elements of the model-assembly. Obviously, with the technical systems sets more elements, respectively, every technical system is a set of more technical parts. Each part of the system is formed as a separate 3D model, and these models assembled into a whole (alike a 3D assembly, but a single 3D model). It is essential that every part of the 3D model as this is established correctly. The safest, perhaps at first seemingly not easiest, method of forming a basic 3D model is to create a model of the basic geometric shape. Why statement "might at first not easiest"? In fact, almost two centuries, in engineering graphic communications was used planar, 2D, displaying technical elements and systems. The engineers and users have acquired the habit of such thinking, presentation and communication. It seems to be easier based complicated contours add a third dimension (which is understandable for engineers who have long been forced to think in 2D where all contours were planar). Technological development of 3D models is possible to make direct, without making a 2D contour. The whole system of thinking is simplified, and the 3D models are formed using basic geometric shapes. In **Figure 21**, it shows an example of forming a shape of the camera (in this case was used only as a unique form of camera model (geometry was used for the formation of a technical element, is not treated as a technical circuit camera system)).

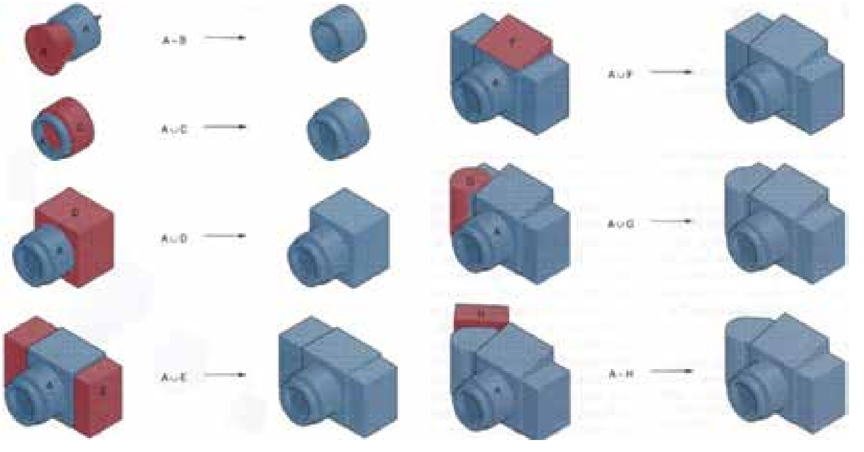

Figure 21. Making a complex 3D model form basic shapes [3].

11. Conclusion

The use of certain computer tools require manual dexterity and knowledge of these tools, however, during the formation of educational methodologies necessary to separate the time for familiarization with these issues. Each graphics software package has its own characteristics, but all are based on a similar graphic philosophy. The idea is that an educational methodology is adapted to the philosophy of preparing the model, while the graphic computer tools are just tools (such as is used in 2D drawing rulers, compasses, pencils, erasers, thin-lead ink pencils, drawing table, etc.), whose role is to a certain custom "facilitate" to the job designer. Using simple technical parts/system, it begins to user training. Of course, in all phases of technical design freehand sketch system, it has its own role. This is one technique that is available to each user, and at any time. I do not see the moment in the future when the need to stop using the freehand drawings in engineering graphic communications. She has always had an important role in this field and will always have it, regardless of the technological advances.

The next level in educational methodology is based on dimensional defining characteristic of technical work/system. At this stage, it is determining the precise geometric characteristics of the model, corresponding to the initial requirements. Sami apron/systems have complicated geometric characteristics, so the modelling process is carried out in several phases. At this level introduces, the initial formation of the technical documentation, as there is enough data for the formation of technical drawings. It is necessary to note that the production of technical drawings on the level of economic development in our country (this is the specificity of the site and the technological development at the state level) is still necessary. Tendencies are to be improved and production of computer-controlled machines to produce technical elements/systems directly with 3D computer models. This is conditioned by economic factors.

By creating precise elements of the system, it is possible to form the whole system. We are entering a phase of assembling component parts into a 3D system, the formation of the necessary documentation. In subsequent stages, it can be made of the analysis formed the system (which cannot be made on the entry level engineering knowledge, but users who already have mastered engineering skills are fully capable of performing the necessary analysis).

The next element of the educational model is based on reversible engineering. This is the one element that is required for each user: recording real technical elements/systems and data for further design and analysis. At this stage, the users are trained and that the data transmitted from technical drawings to the formation of the 3D model.

Finally, education in the field of technical graphic communication comes to the stage of the formation of the entire technical elements/systems, to the coverage of all phases.

Acknowledgements

This work was financially supported by the Ministry of Science and Technological Development of the Republic of Serbia through Project No. TR 35011.

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Chapter 5

Quality Assurance in Virtual Learning Environments for Open Distance Learning

Victor J. Pitsoe and Matsephe M. Letseka

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65746

Abstract

Quality assurance, as the fundamental pillar of higher education development, continues to remain an integral part of the e-learning process. Most importantly, it influences reforms in higher education institutions globally. This chapter departs on the assumptions that (1) quality assurance, as power relations construct, is not free from cultural hegemony and (2) quality assurance in virtual learning environments should be guided and informed by Paulo Freire's humanizing pedagogy. In this chapter, we shall argue that quality assurance is both a philosophical problem and a policy imperative that is critical for the internationalization and globalization of higher education, more specifically virtual learning environments. We will further argue that the emphasis placed on the importance of quality assurance in virtual learning practices has been blind-spotted by the fact that quality assurance can be viewed as agent of cultural hegemony and cultural reproduction of capitalist societies. While we agree with all the positive elements attributed to quality assurance in virtual learning, we argue that they should be characterized by humanizing pedagogy and the international dimension (exchange of knowledge and interactive networking) and cultural hybridity.

Keywords: quality assurance, quality, hegemony, ideological state apparatus

1. Introduction and background

Quality assurance (QA) is not a new phenomenon—it is on the agenda of many educational institutions globally. Within the academic world and in higher education policy, QA is used as a tool for rankings in higher education (HE). Federkeil [1] writes that "rankings have become a widespread phenomenon in an increasingly competitive world of higher education. They differ with regard to their aims, objectives, target groups, and with regard to their relationship to quality and quality assessment." Nonetheless, it has sparked numerous discourses in and outside academia. Perhaps, it is noteworthy to mention that quality assurance has the material attributes of an ideological construct. As the fundamental pillar of higher education development, quality assurance continues to remain an integral part of the e-learning process and virtual learning environments (VLEs). While "social norms, values, and acceptable forms of behavior vary widely from culture to culture" [2], our thesis is that the dominant quality assurance practices in VLEs do not take into account the different cultural attitudes within the classroom.

Although some may deny it: (1) quality assurance, as a power relations construct, is not free from cultural hegemony and (2) quality assurance in VLEs should be guided and informed by Paulo Freire's humanizing pedagogy. Hence, open distance learning (ODL) institutions are also coming under pressure to guarantee that their virtual learning practices are anchored by credible quality assurance policies. In this chapter, we shall argue that quality assurance in VLEs is both a philosophical problem and a policy imperative that is critical for the internationalization and globalization of higher education. Notwithstanding the fact that a significant number of studies have shown that VLEs enhance student learning, we will further argue that the emphasis placed on the importance of quality assurance in virtual learning practices has been blind-spotted by the fact that quality assurance can be viewed as an agent of cultural hegemony and cultural reproduction of capitalist societies.

Oyaid and Al-Hosan [3] remind us that the "availability of quality in virtual and e-learning is a very important issue for any academic course, program, and educational environment." They further argue that "if quality is a prerequisite for the success of the educational process in general, it is essential for virtual and e-learning in particular." While we agree with all the positive elements attributed to quality assurance in VLEs, we will argue that they should be characterized by humanizing pedagogy and the international dimension (exchange of knowledge and interactive networking) and cultural hybridity. Drawing on the works of Paulo Freire, Basil Bernstein, Antonio Gramsci, and Louis Althusser, this chapter will (1) theorize quality assurance in the VLEs; (2) argue quality assurance as a practice of symbolic control; (3) present quality assurance as cultural hegemony; (4) critique quality assurance as an ideological state apparatus (ISA); (5) present Paulo Freire's humanizing pedagogy; and (6) propose a rethinking of quality assurance in VLEs through the lens of humanizing pedagogy.

2. Theorizing quality assurance in VLEs and e-learning

The notion of quality of teaching is derived from consumerization and standardization of higher education. Yet, the notion of quality assurance in the VLEs and e-learning is constantly evolving, very fluid in nature and is broadly perceived. Quality, just like "freedom" or "justice," is an elusive concept, instinctively understood but difficult to articulate [4]. The concept is easily misconstrued because of its rather vague characteristics. Most scholars consider quality as extremely elusive, slippery, dynamic, multidimensional, and a relative concept. Throughout the history of quality assurance, various iterations of what good quality means have come and gone. We need to take cognizance that the concepts of "quality" and "quality assurance" are not unproblematic. Both concepts have very different meanings and

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interpretations to both the providers of and the consumers of quality and quality assurance. In essence, the concepts "quality" and "quality assurance" are to a large extent amorphous and contextual. Included here are some definitions of some of the shared understandings of the notion of quality assurance in the VLEs and e-learning in ODL context.

Quality can be defined as the embodiment of the essential nature of a person, collective object, action, process, or organization. For most scholars [5–12], quality in education is a combination of exceptional high standards; perfection and consistency; fitness for purpose; value for money; transformation capabilities; and product of planning, monitoring, control, and coordination. In a nutshell, Harvey [9] captures notion of quality in five categories. He sees quality as: (1) *something special* (something distinctive and elitist); perfection (consistent or flawless outcome); fitness for purpose (fulfilling a customer's requirements, needs, or desires); value for money (in terms of return on investment); and transformation (in terms of change from one state to another).

Against this backdrop, the quality of online education is a central issue for the sustainable delivery, development, and future of technology-supported learning. Oyaid and Al-Hosan [3] note that "the concept of quality in virtual and e-learning is associated in the literature and recent studies with the outcome of the educational process, most definitions of quality in e-learning have described it in terms of measuring or testing the effectiveness and quality of e-learning programs in accordance with standards and benchmarks." Biggs (as cited as cited in [3]) "calls such quality assurance processes *retrospective* activities, because they look back to see what has been done rather than looking forward (*prospective*) to see what can be done to transform and change educational processes to improve the service delivery."

3. Quality assurance as a practice of symbolic control

To start with, quality assurance does not exist in isolation. It is profoundly connected in/to the politics of "symbolic control" and is consistent with Bernstein's [13, 14] *Model of Transmission Context*—it has the attributes of *classification* and *framing*. Bernstein [15] conjures that "symbolic control is legitimized by a closed explicit ideology, the essence of weak classification and weak frames" (p. 111). According to Bernstein [16], ideology is not content, but a way of making and realizing relationships. Hence, it could be argued that quality assurance, as invisible pedagogy [17], fits through the lens of specialized agencies of symbolic control. Within this context, we hold that in the VLEs and e-learning space, quality assurance demonstrates, through the values of "*classification* and f*raming*, how power and control is differentially distributed between the transmitter and acquirer in the quest to create contextually appropriate text" [14].

It is important here to indicate that, as Bernstein and Solomon [18] observe, "symbolic control is materialised through a pedagogic device (which is the condition for the construction of pedagogic discourses). The device consists of three rules which give rise to three respective arenas containing agents with positions/practices seeking domination." For them, a pedagogic device consists of: (1) distributive rules attempt to control access to the arena for the legitimate production of discourse; (2) pedagogic discourses are projected from positions in the reconceptualizing arenas; and (3) evaluative rules shape any given context of acquisition" (p. 269). **Figure 1** illustrates Bernstein's model of transmission within any pedagogic context.

The model of transmission context is central to the recognition and realization rules. While recognition and realization rules are in effect functions of classification, Bernstein's [14] model (1) "provides an overview of how the distribution of power and the principles of control translate into classification and framing values which select out recognition and realisation rules to create contextually appropriate text" (p. 18); and that (2) "recognition rules regulate what meanings are relevant and realization rules regulate how the meanings are to be put together to create the legitimate text" (p. 18). Within Bernstein's [14] model of transmission context, the interactional practice can be constructed as the transmission process of quality assurance policy dissemination. Hence, the higher education institutions and ODL practitioners interact with the transmitters via visual, verbal, and electronic representations. With this in mind, Bernstein [15] emphasize that

> *"the recognition and realisation rules are in effect functions of classification and framing where the recognition rules create the means of distinguishing between, and so recognizing the speciality that constitutes a context [or voice] and realisation rules 'regulate the creation and production of specialized relationships, internal to that context'[or message]".*

Notwithstanding the fact that the symbolic control theory is not always welcome, or well treated, in the Anglo-Saxon intellectual milieu, "it has provided inspiration for theoretical work in a variety of disciplines and the conceptual framework for robust and sensitive sociological empirical research on cultural and, particularly, pedagogic practices and their effects, in many parts of the world" [18]. Yet, it could be argued that quality assurance is never simply a neutral assemblage of knowledge appearing in the VLEs and e-learning settings—it is fragment of "selective tradition" and the dominant group's vision of legitimate knowledge. In his work *Official Knowledge: Democratic Education in a Conservative Age*, Michael Apple [19] convincingly demonstrates that "What counts as legitimate and one's right to determine it is lodged in a complicated politics of symbolic control of public knowledge" (p. 63).

In view of all that has been mentioned so far, one may suppose that, quality assurance fits through Basil Bernstein's lens of "symbolic control." The *being*-ness and the *is*-ness of qual-

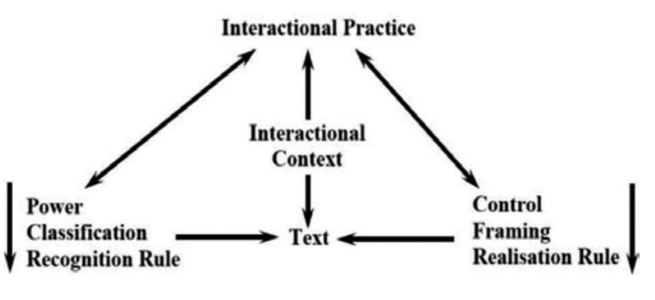

Figure 1. The model of transmission context. Adapted from Bernstein [14] (p. 16).

ity assurance as (1) invisible pedagogic device, (2) ontology and epistemology, (3) social construction, (4) social reproduction, and (5) social representation are introduced through the distributive rules. From Bernsteinian perspective, there is symbiotic relationship between the concepts quality assurance and "symbolic control." Hence, the concept "symbolic control," as a conceptual tool, is central in understanding the discourses on quality assurance in the VLEs and e-learning context. Perhaps, it is worthwhile to mention that VLEs and e-learning contexts are regulated by symbolic control (specialized and dominant forms of communication).

One interesting conclusion is that quality assurance, in the VLEs and e-learning context, has the attributes of "interactional practice," and can be perceived as classification (power) and framing procedures (control) which act selectively on the recognition and realization rules, where the text is considered to be "anything which attracts evaluation" [14]. As Bernstein [16] notes, "control is double faced for it carries both the power of reproduction and the potential for its change" (p. 19). Another important observation is that the recognition and realization rules are in effect functions of classification and framing in quality assurance. According to Bernstein [14, 17], "recognition rules regulate what meanings are relevant and realization rules regulate how the meanings are to be put together to create the legitimate text" (p. 18). For him, "set of rules shape the creation, reproduction, and possible transformations of specialised contexts."

With this in mind, we can infer that the notion of quality assurance in VLEs and e-learning context as a dominant discursive code shapes legitimate ways of thinking and ways of relating carries the attributes of regulative and discursive rules, symbolic control, and identity [14, 16, 20–26]—it acquires its *being*-ness and *is*-ness through cultural reproduction. Hence, quality assurance in the VLEs and e-learning context can be seen as the dominant agent of the field of symbolic control and hegemony that regulate the means, contexts, and possibilities of discursive resources. It could be concluded that quality assurance (in the VLEs and e-learning in ODL) is a process through which ruling power consolidate symbolic control and hegemony.

4. Quality assurance as a cultural hegemony

It is important to stress that, quite often the notion of "hegemony" is associated with issues of power and is broadly perceived. In the case of this chapter, we will draw on Antonio Gramsci's hegemony, as the key concept in understanding the very unity existing in a concrete social formation. For us, Gramsci's theory of hegemony is a fundamental part of quality assurance in VLEs and e-learning in ODL space as key sites for practicing "symbolic control" and "hegemony." We argue that the dominant group or the bourgeois society, through combining the ideas of "symbolic control" and "hegemony," gains social power. In the context of VLEs and e-learning quality assurance, power can be gained by a closed explicit ideology (classification and framing procedures). Yet, the notion of "classification" of Bernstein and the idea of "hegemony" of Gramsci have a symbiotic relationship. Despite the fact that both concepts "classification" and "hegemony" have political, moral authority, and control connotations, perhaps it is noteworthy to emphasize that Gramsci and Bernstein's works are the analytical tools to explore the link between quality assurance and dominant and/or the ruling power.

The VLEs and e-learning in the ODL are complex and evolving and have significant operational as well as academic challenges. Hence, assuring and enhancing the quality of teaching and learning in VLEs and e-learning in ODL institutions are currently a major concern. In Gramsci's theory, hegemony is the term for the social consensus, which masks people's real interests. The hegemonic processes take place in the superstructure and are part of a political field [27, 28]. From a Gramscian stance, Pitsoe and Dichaba [29] emphasize that "the basic premise of the theory of hegemony is that man is not ruled by force alone, but also by ideas." Citing Gramsci [30] and Bates [31], Pitsoe and Dichaba [29] further indicate that "the foundation of a ruling class is equivalent to the creation of a *Weltanschauung*"; and that "the ruling ideas of each age have ever been the ideas of its ruling class" [31].

In a Gramscian sense, hegemony is both discursive and political. Among others, it includes the power to establish "legitimate" definitions of social needs and authoritative definitions of social situations. It involves the power to define what counts as "legitimate" areas of agreement and disagreement. As Pitsoe and Dichaba [29] write, "hegemony describes the power exercised by the ruling class over the population in order to maintain "control" of the means of production." Citing Gramsci [30], they further note that "hegemony is a form of control exercised primarily through a society's superstructure as opposed to its base or social relations of production of a predominately economic character." For Pitsoe and Dichaba [29], "hegemony is consent protected by the armor of coercion. Perhaps, it is critical to emphasize that "through the power of consent, hegemony finds its way toward obtaining the spontaneous collaboration of the individuals, in order to uphold the political *status quo* in the long term" [29]. Hegemony is not a static concept—it is very complex and fluid in nature. It functions to define the meaning and limits of common sense as well as the forms and content of discourse in society" [32, 33]; and "reinforces or reproduces the political and economic dominance of one social class over another" [34]. Drawing from Williams [35], Pitsoe and Dichaba [29] conclude that (1) "hegemony exceeds ideology in its refusal to equate consciousness with the articulate formal system which can be and ordinarily abstracted as ideology; and that (2) hegemony attempts to neutralize opposition, the decisive hegemonic function is to control or transform or even incorporate (alternatives and opposition)."

In the light of the above analysis, studying quality assurance in the VLEs and e-learning from Gramscian perspective involves two major theoretical shifts. First, from a philosophical perspective, hegemony and quality assurance, as both ideological constructs, have a symbiotic relationship. In short, it would seem that quality assurance is a power relations construct. Quality assurance, as a form of powerful bureaucracy, is compatible with the behavioristic view of learning, in which both curriculum and instruction are broken down into small, sequential steps dictated by the practitioners. Just like the Industrial Revolution, which called for the redesign of schools in order to prepare a labor force for new forms of work and citizenship, the fluid nature of the VLEs and e-learning settings calls for new forms of quality assurance practices that are consistent with a reflexive practice. Second,

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there is a *prima facie* case for hegemony playing a part in quality assurance. Understanding quality assurance as praxis, identity, status, virtue, or agency is a hegemonic approach to the concept. It is also an ideological approach, based on idealist articulations of what quality assurance should be.

5. Quality assurance as an Ideological State Apparatus

Ideology is a fundamental property of quality assurance in the VLEs and e-learning in ODL settings. From Althusserian perspective, quality assurance advances the materiality of ideology and serves to reproduce the relations of production. The central thesis of this section is that ideology is inescapable, it lives in quality assurance and constitutes quality assurance; and continues to be the powerful force behind the dominance of hegemonic institutions. Hence, it could conceivably be hypothesized that quality assurance, as a metaphysical construct, (1) represents the imaginary relationship of individuals to their real conditions of existence; and (2) interpellates concrete individuals as concrete subjects. In addition, we depart on the assumption that quality assurance is compatible and consistent with notion of educational Ideological State Apparatuses (ISA)—it functions by ideology and repression, and it "has the function of regulating the relation, of individuals to their tasks, and, in so doing, ensuring the cohesion of the social whole" [36].

Yet, it should be noted that Louis Althusser's work, as a theoretical tool, is not alien to critiquing quality assurance practice in the in the VLEs and e-learning. Central to this chapter is the assumption that quality assurance, as a social construct and the struggle over knowledge control, pertains to Althusser's theoretical framework. Let us explain. In his work, Lenin and Philosophy and Other Essays, Althusser [36] distinguishes between two forms of state apparatuses: the Ideological State Apparatus and the Repressive State Apparatus (RSA). He calls Ideological State Apparatuses realities which present themselves to the immediate observer in the form of distinct and specialized institutions [36]. For Althusser [36], "repressive apparatuses function by violence" (p. 145).

Althusser (1971) reminds us that, "ISAs include education, religion, family, legal system, political system, culture, mass media, trade unions, which he says are primarily private. It is also worth mentioning that these are the agencies that function by violence, by at some point imposing punishment or privation in order to enforce power." As Althusser [36] puts it, "all the state apparatuses function both by repression and by ideology, with the difference that the RSA functions massively and predominantly by repression, whereas the ISAs function massively and predominantly by ideology" (p. 149). While ideology "interpellates" subjects, in Althusser's [36] framework, hailing individuals into social beings, quality assurance as ideology, works to secure the *hegemony* (p. 150). Althusser [36] says that an "ideology always exists in an apparatus, and that while ideology in general has no history, specific ideologies have histories of their own. Ideologies interpellate people into defined subject positions through the ISA." The "subjects" thus are far less likely to oppose their status in life since they accept the "practices."

Althusser's [36] position is that "all ISAs, whatever they are, contribute to the same result: the reproduction of the relations of production, i.e., of capitalist relations of exploitation" (p. 153). For him, the "reproduction of the relations of production, the ultimate aim of the ruling class, cannot therefore be merely technical operation training and distributing individuals for the different posts in the 'technical division' of labour" (p. 183). Most importantly, Althusser theorizes that ideology "has a material existence and that each ISA is the 'realization of an ideology'" (p. 166). He concludes that ideology "always exists in an apparatus, and its practice, or practices" and that "individuals are always-already interpellated by ideology as subjects," which implies that the "individual is always-already subject," "even before he is born" (p. 176).

In summary, it should be admitted without prevarication that the quality assurance practice, as both an institution and ideology, fits perfectly through the lens of ISA. It is intended to perpetuate social reproduction and political hegemony. Particularly, it advances the reproduction of capitalist relations of production. Through quality assurance practice, as epistemological hegemonic dominance, individuals are transformed into subjects through the ideological mechanism. Althusser [36] concludes that the "reproduction of labour power requires not only a reproduction of its skills, but also, at the same time, a reproduction of its submission to the rules of the established order" (p. 132).

6. Paulo Freire's humanizing pedagogy

From a historical point of view, humanizing pedagogy was first enunciated by Paulo Freire, the most prolific and polyphonic voice of twentieth century philosophy on critical pedagogy. In his work Pedagogy of the Oppressed, Freire [38] presents humanizing pedagogy as a philosophical approach that fosters critical, dialogue, and liberatory practices. Among others, he makes a call to counter hegemonic education and dehumanizing pedagogies. As Freire [38] writes, humanizing pedagogy is "a teaching method that ceases to be an instrument by which teachers can manipulate students, but rather expresses the consciousness of the students themselves" (p. 51). For this reason, he contends that "teachers who are able to promote a humanizing pedagogy are more apt to develop mutual humanization in a dialogic approach with their students in which everyone ultimately develops a critical consciousness" (p. 56). Freire [38] asserts that "concern for humanization leads at once to the recognition of dehumanization, not only as an ontological possibility, but also as a historical reality" (p. 43). Recently, there has been renewed interest in humanizing pedagogy. It is critical to mention that humanizing pedagogy is fast becoming a key instrument in the diverse VLEs and e-learning settings. However, a significant number of scholars [37–40] perceive "humanizing pedagogy as a process of becoming for students and teachers." Freire [38] asserts that "concern for humanization leads at once to the recognition of dehumanization, not only as an ontological possibility, but also as a historical reality." Notwithstanding the fact that Freire has often been criticized for the "universalist" nature of his theory of oppression and liberation, the notion of humanizing pedagogy is critical in educational leadership. Freire urges readers to recognize that humanizing pedagogy is concerned with transforming relations of power which

http://dx.doi.org/10.5772/65746

are oppressive and which lead to the oppression of people. Most importantly, it "transforms oppressed people and to save them from being objects of education to subjects of their own autonomy and emancipation" [41].

In Pedagogy of the Oppressed, Freire [38] reminds us that "humanizing pedagogy is a teaching method that ceases to be an instrument by which teachers can manipulate students, but rather expresses the consciousness of the students themselves." For him, "teachers who are able to promote a humanizing pedagogy are more apt to develop mutual humanization in a dialogic approach with their students in which everyone ultimately develops a critical consciousness" (p. 56). With this in mind, Huerta [42] tells us that "teachers who embrace a humanizing pedagogy recognize the sociohistorical and political context of their own lives and their students' lives, including the influence of societal power, racial and ethnic identities, and cultural values" (p. 39). She further argues that "these teachers believe that marginalized students (due to race, economic class, culture, or experience) differ in how they learn, but not in their ability to learn." For her, (1) "teachers who practice a humanizing pedagogy incorporate students' language and culture into the academic context to support learning and to help students identify with, and maintain pride in, their home cultures; and (2) teachers who practice a humanizing pedagogy explicitly teach the school's codes and customs, and/or mainstream knowledge, to enable students to fully participate in the dominant culture."

On the one hand, McLaren [43] remarks that humanizing pedagogy means aiming to "transform existing power and privilege in the service of greater social justice and human freedom" (p. 46). On the other hand, for most scholars [37, 39, 44–46], humanizing pedagogy means aiming to "develop the whole person (in contrast to only developing their knowledge/skills in one particular discipline), and their awareness of self in relation to others and context"; recognizes the importance of, "the students' background and knowledge, culture, and life experiences and creates learning contexts where power is shared by students and teachers" [47]. In the same vein, Wood [48] observes that "a humanizing pedagogy informs us that we can learn from those we may deem to be inferior and furthers the wellness of all human beings, rather than only transferring academic knowledge" (p. 832).

In summary, "humanizing pedagogy respects and uses the reality, history, and perspectives of students as an integral part of educational practice" [37]. In addition, humanizing pedagogy "creates learning contexts where power is shared by students and teachers" [47]. For Bartolomé [37, 47], the concept of dehumanizing pedagogy involves the "deficit approaches in teaching that result in discriminatory practices for strip students of the cultural, linguistic, and familial aspects that make them unique, self-possessed individuals." Similarly, Freire [38] emphasizes that "there is no learning or humanization without the act of mutual dialogue. Yet for dialogue to be transformative it needs to be carried out in relations of love, mutual respect, and trust." Freire [38] was profoundly convinced that "if the capacity to dialogue offers an alternative to the 'banking concept' of education, it does so because it no longer reduce the oppressed human being to the status of a thing or object." Hence, a "humanising pedagogy expresses the consciousness of the students" [38]. In the next section, we consider rethinking quality assurance in VLEs through humanizing pedagogy lens.

7. Rethinking of quality assurance in VLE through the lens of humanizing pedagogy

Robinson [49] notes that "while the adoption of VLEs is becoming widespread among universities worldwide, the cultural background of students in these institutions, especially in Western societies, have become increasingly diverse." For him, "cultural diversity can bring enrichment to the classroom, and the VLE can be rewarding in facilitating flexible teaching and learning, networked learning and cross-cultural communication, as examples of benefits." However, Robinson [49] writes that "while it may be crucial for HEIs to take full advantage of e-learning opportunities, the most pressing concerns are the impact that the VLEs may have on students' cultural differences, their online expectations and ultimately, their learning outcomes." Against this backdrop, we raise this important question: To what extent does the dominant quality assurance in VLE embrace students' cultural differences?

Perhaps it is apt to indicate that the work of Freire is not alien to the field of quality assurance practices in VLEs and e-learning, he continues to stand as an intellectual giant in the field of humanizing pedagogy. For this reason, humanizing pedagogy is crucial for exploring quality assurance in VLEs and e-learning. Among others, in the twenty-first century, quality assurance in VLEs and e-learning is very complex and chaotic—it is caught in a theoretical impasse. Hence, the state of dehumanization in dominant quality assurance practices in VLEs and e-learning calls for counter practice to dehumanization in education. In coming to grips with the philosophy of Freire, a great deal hinges on understanding his dialogue on alternative "banking concept of education." Freire [38] very explicitly and dramatically announces a move from dehumanizing to humanizing education.

It is essential to mention that "humanizing pedagogy" (also known as a process of *conscientizacão*) is broadly perceived. Notwithstanding the fact that humanizing pedagogy has many faces and histories, there is a growing interest in a critical agenda within higher education. Given its complex and fluid nature, the concept of "humanizing pedagogy" remains contested at the levels of theory, definition, and praxis. However, humanization, as a social construct, is both a philosophical problem and a policy imperative—it is central in the discourses of decolonization and dehumanization of education (from schools to institutions of higher education, as principal ISAs). Perhaps, it is noteworthy to indicate that humanizing pedagogy advocates continual critique and disruption of existing ideologies and structures; and strive toward social improvement and an eradication of the social inequalities that prevail in the oppressed societies. Hence, humanization is the "ontological vocation of man" [50] and sustains the epistemological and ontological modes of student voice.

Humanizing pedagogy is rooted in critical pedagogy. It is an undeniable fact that humanizing pedagogy is consistent with the "right" teaching strategies; and values students' (and teachers') background knowledge, culture, and lived experiences. Among others, humanizing pedagogy negates the "banking" concept of education. It could be argued that the banking concept of education is an act of depositing (the teachers are the depositor and the students are the depositories). In the words of Freire [38]:

> *"the banking concept of education as an instrument of oppression—its presuppositions—a critique"; the problem-posing concept of education as an instrument for liberation—its presuppositions; the "banking" concept and the teacher-student contradiction; the problem-posing concept and the supersedence of the teacher-student contradiction; education: a mutual process, world-mediated; people as uncompleted beings, conscious of their incompletion, and their attempt to be more fully human."*

To end this section, with the growing influence of postmodernism and poststructuralism, there is a need for a revolutionary shift in assessment practice in terms of theory and practice. Among others, ODL quality assurance should be coined in such a way that it meets the needs of culturally diverse students. One plausible solution is to rethink ODL quality assurance practices through humanizing pedagogy lens.

8. Conclusion

In this chapter, we have drawn on the works of Paulo Freire, Basil Bernstein, Antonio Gramsci, and Louis Althusser. We stressed that the notion of quality assurance in the VLEs and e-learning is constantly evolving, very fluid in nature, and is broadly perceived. We further delineated that quality in education is a combination of: exceptional high standards; perfection and consistency; fitness for purpose; value for money; transformation capabilities; and product of planning, monitoring, control, and coordination. Next, by employing Bernstein's Model of Transmission Context, we contended that quality assurance is a practice of symbolic control and cultural hegemony in that it has the attributes of classification and framing. We conjured that the notion of quality assurance in VLEs and e-learning context as a dominant discursive code, shapes legitimate ways of thinking and ways of relating, carries the attributes of regulative and discursive rules, symbolic control and identity, and acquires its *being*-ness and *is*-ness through cultural reproduction. Hence, our conclusion that quality assurance in the VLEs and e-learning context can be seen as the dominant agent of the field of symbolic control and hegemony that regulate the means, contexts, and possibilities of discursive resources. It could be concluded that quality assurance (in the VLEs and e-learning in ODL) is a process through which ruling power consolidate symbolic control and hegemony.

We also presented quality assurance as a symbol of power by using Antonio Gramsci's notion of hegemony. We argued that Gramsci's theory of hegemony is a fundamental part of quality assurance in VLEs and e-learning in ODL. We further argued that the dominant group or the bourgeoisie gains social power through combining the ideas of "symbolic control" and "hegemony." We demonstrated that quality assurance is compatible and consistent with notion of educational Ideological State Apparatuses (ISA), that in the same way as education, quality assurance functions through ideology and repression, and it "has the function of regulating the relation of individuals to their tasks, and, in so doing, ensuring the cohesion of the social whole." Our conclusion is that quality assurance practice, as both an institution and ideology, fits perfectly through the lens of Ideological State Apparatus. It is intended to perpetuate social reproduction and political hegemony and advances the reproduction of capitalist relations of production. The quality assurance practice transforms individuals into subjects through the ideological mechanism.

In the final two sections, we discussed Paulo Freire's humanizing pedagogy and proposed a rethinking of quality assurance in VLEs through the lens of humanizing pedagogy. We began by exploring Paulo Freire's [38] argument of humanizing pedagogy as a philosophical approach that fosters critical, dialogue, and liberatory practices. We concurred with Freire that humanizing pedagogy should be a teaching method that ceases to be an instrument by which teachers can manipulate students, but rather should express the consciousness of the students themselves. Then we proposed a rethinking of quality assurance based on humanizing pedagogy. We demonstrated that by its virtue of being rooted in critical pedagogy, humanizing pedagogy can assist to create a revolutionary shift in assessment practice in terms of theory and practical. Humanizing pedagogy can facilitate the coining of ODL quality assurance in such a way that it meets the needs of culturally diverse students.

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Chapter 6

'Women on a Wiki': Social Constructivist Analysis of the Effectiveness of Online Collaborative Spaces for Reflective Learning in Women's Health Studies

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65298

Abstract

Public health undergraduate students studying the unit *Women's Health* undertook a teaching and learning exercise which required them to learn to create and use a wiki website for reflective learning purposes. A wiki is a group of web pages that allows users to add content, similar to a discussion forum or blog, while permitting others to edit and provide feedback. The *Women's Health* wiki provided an online shared, collaborative and creative space wherein the students' perceptions of women's health issues could be discussed, reflected upon and debated. This chapter develops a social constructivist theoretical framework for analysing the content developed on the *Women's Health* wiki by the students and provides a theoretical model for how the wiki worked to aid reflective and critical thinking, as well as developing technological and communicative skills among students, and discusses implications for their future use in a tertiary setting.

Keywords: technology, public health, women's health, education, wiki

1. Introduction

The use of online pedagogy within higher education institutions is increasing [1], with information communication technology (ICT) mediums used to promote interactive environments and new approaches to learning, including a broad engagement of Web 2.0 platforms [2, 3]. Web-based technologies known as Web 2.0 [4], allow users to provide information and promote collaborative environments [5]. The use of Web 2.0 tools provides greater independence, collaboration and autonomy among students [5]. These e-learning tools promote self-learning, stimulate students to delve deeper into issues presented to them and keep students interested in the learning process [2, 5, 6]. Studies conducted by Sarkar [1] found that the use of ICT mediums improved the quality of education of students in three ways: augmenting student enthusiasm and commitment, promoting thought provoking ideas and influencing collaborative environments [1]. Higher education institutions have been quick to adopt ICT mediums to facilitate collaborative learning environments among students [7].

ICT mediums, including most Web 2.0 programs, are also seen as playing a significant role in the empowerment of young adult women [8–10]. Umrani and Ghadially [11] posit that the use of ICTs by women have led to increased self-esteem and significant knowledge gain. This not only broadens the spectrum of learning, but empowers women to make more informed decisions on issues that affect them, like their health and well-being. Refs. [9, 11, 12] concur with these findings and suggest that ICT mediums empower women by actively involving them in contributing ideas, articulating their opinions and asserting their autonomy on issues that women face today. The perceived benefits of ICTs are consistent throughout the literature [2, 7]. Even though ICT mediums play a significant role in empowerment of women, women are underrepresented in the ICT industry both in Australia and internationally [13–16]. Women account for just under 30% of the total workforce within the ICT sector [17], 21% at professional level, 18% when electronics and communications workers are included and drops to 15% when all the relevant trades assistants are included [17]. Female participants in the ICT workforce has changed little over time, maintained relatively steady at around 16% over the past 6 years [18].

While women are underrepresented in the ICT's highly paid professions, occupations and research, they remain a very high-level user group when it comes to seeking and obtaining support and advice online for health issues such as conception, contraceptive, pregnancy, depression, anxiety, child rearing, breast cancer and healthy ageing [19–22]. Women are more likely to utilise the Internet for health information specific to their health concerns and tend select information from a vast range of sources and websites and use a combination of sources to make their own decisions about their health and their paths of treatment [12, 20, 22–28].

In light of the evidence showing *first* that while women are active users of existing technologies—including using ICTs (mobile apps, social media, government websites), they are less confident in producing and creating it, and *secondly*, that technological skills are important for academic and career enhancement and professional opportunity, public health students studying in the final year of the Public Health degree, and who had selected the unit *Women's Health*, undertook a teaching and learning exercise which required them to learn to create and use a wiki website for reflective learning purposes. A wiki, an example of Web 2.0 tool, is a group of web pages that allows users to add content, similar to a discussion forum or blog, while permitting others to edit and provide feedback [29]. In essence, a wiki is an effective tool used to exchange information through collaborative effort [6]. Carroll et al. [30] also suggest that the application of wikis or wiki spaces in education settings has proven to be instrumental in the enhancement of students' learning experiences and academic outcomes.

http://dx.doi.org/10.5772/65298

Each student created their own wiki page on a shared wiki set up for Women's Health. The wiki provided an online shared, collaborative and creative space wherein the students' perceptions of women's health issues could be discussed, reflected upon and debated.

This chapter will first develop a social constructivist theoretical framework for analysing the content developed on the Women's Health wiki by the students over the course of the semester; secondly, it will describe the methodology of the assessment; thirdly, it will demonstrate how the wiki content was analysed; fourthly, it will demonstrate the key learning themes that emerged via the weekly reflective posts by students; and finally, provide a theoretical model for how the wiki worked to aid reflective and critical thinking in this context and provide implications for their future use in a tertiary setting.

2. Social constructivist framework for use of interactive and social websites for reflective learning practices

The social constructivist approach initiated by Vygostsky [31] and further developed by Jonassen [32] was used to analyse students' contributions in relation to four key thematic outcomes. Vygostsky's [31] work was founded in the principles introduced by Piaget, who focused on the role of social dynamic and interpersonal dynamics in generating knowledge. Piaget stated that every function in a child's cultural development appears twice. First on the social level and second on the individual level [31]. Vygostsky [31] developed these ideas into a theoretical platform for learning that transformed the notion of the teacher/lecturer as a 'transmitter of knowledge' to a role that provided spaces for interactions that allowed learning to occur; between teacher and student, and between student and student. Jonassen [32] further developed this theoretical basis of interactive learning into the following four stages of critical thinking development:

1. **Complexities in representations across contexts:** This describes the process wherein students start to recognise complexity and contradiction in how concepts and people are represented in different settings. In this case, the students focused on how this applies to the portrayal of gender in the media.

2. **Critical evaluation in real-world scenarios:** Wherein the students apply theory to evidence; they bring together new theoretical concepts and find examples of where these can be found in everyday real world practice.

3. **Reflective practice based on experience:** Students combine new theory and evidence and bring it back to their own experiences. This is a crucial part of constructivist reflective learning as the students seek and locate stories from one another and insights from themselves to apply their learning and ground it in a sustained new level of knowledge.

4. **Collaborative co-construction of knowledge**: Interactive and continuous dialogue wherein the learning processes are situated and developed for all those involved in the interactions.

Both text and image/visual contributions are provided as examples within each of these learning processes. All data on the wiki was analysed in accordance with a social constructivist approach. According to Tam [33] constructivism is a fundamental departure in thought about the nature of knowing, hence of learning and thus of teaching. To facilitate the understanding of the constructivist view and its implications, it is compared to a familiar mental model of learning held by many: the objectivist epistemology. Guiding the discussions on constructivism and its implications for teaching and learning are four main questions: *What is learning? What is the learning process? What is the teacher's primary role in the learning process? What can the teacher do to carry out that role?* We utilised Ref. [32] for constructivist categories to address these questions in relation to an online reflective learning diary assessment.

3. Methodology: the wiki assessment

The aim of the wiki assessment was to encourage students to use their critical and reflective thinking skills for the theoretical analysis of women's health issues using feminist theory. They were encouraged to question, critique and reflect on the content of weekly women's health lectures to generate a deeper understanding of the policies and practices which impact on women's health at the government, community, family and individual levels. The aim of this pedagogical process was to encourage students to observe, critique and reflect on the topics covered during the women's health lecture. They are to take into account the ethical, theoretical and philosophical analysis of the issues relevant to women's health and to consider the implication of their analysis for equity, inclusion, policy and implication for women's health.

3.1. The assessment task

Students were invited to join the Women's Health Wiki in Wikispaces (http://www.wikispaces.com/) for the unit. They followed the steps outlined during the lecture to generate their own wiki page at this website and enter their reflections weekly. You can view the full Women's Health Wiki here: http://pub336womenshealth.wikispaces.com/

3.2. Reflection of women's health issues on the wiki

Students were required to write around 250 words in their wiki every week on the lecture content. Students were free to make notes in class during the lecture directly onto these wikis—if they have laptop/ipad or can make entries after the class in their own time. Students were encouraged to question the content of the lecture being presented. The weekly wiki entries were written informally. The entries were designed to encourage student to engage with the work being presented in a reflective manner as the semester progresses. Students were encouraged to question and critique the content of weekly women's health lectures. Students can also add references, web links, online resources or images/songs/films that they think will augment the content studies that week. The idea is to help students to learn together, to share ideas and to ask hard questions about the complex women's health topics covered in the unit while developing technological skills. Students were also required to comment on the reflective notes of at least one other student.

4. Research questions

1. Can shared ‘cyber spaces’ be occupied by undergraduate women's health students to improve students’ critical thinking skills and what are the processes via which this occurs?

2. Does the interactive process of sharing and comparing assessment items generate collaboration and competition amongundergraduate students wherein more critically informed arguments are made about public/popular media sources depicting issues in women's health?

3. What are the implications of this assessment trial for future teaching practices in undergraduate courses, especially those utilising reflective learning assessment pieces?

5. Data collection

The students’ weekly wiki entries were observed closely by the unit's teaching staff throughout the duration of the assessment. Comments by teaching staff sought to encourage and foster new ideas along with greater depths of understanding and critical thinking. Students were encouraged to think broadly about the topics for reflection and were expected to use a range of sources from which to form their conclusions. Students were therefore assessed on their use of lecture content, tutorial material, observations from media and empirical evidence as the basis for their reflections.

Secondly, and following the completion, submission, marking and returning of grades and feedback to the students on their wiki page reflection, we asked them the following questions:

- What did you think of the ‘*Wiki Diaries and Reflection*’ when it was first introduced at the beginning of the semester?

- What did you think of the ‘*Wiki Diaries and Reflection*’ after completing the assessment at the end of the semester?

We received a wide range of in-depth written responses from students about their initial reactions to this assessment piece, their strategies for engaging with the task, their learning processes during the task and their final reflections on the assessment overall.

6. Analysis and findings from the women‘s health reflective learning wiki diaries

All (about 360) diary entries were analysed using Jonassen's [32] four conceptual categories described in the theoretical section of this chapter. The following sections itemise and highlight the most pertinent examples of where these learning processes occurred. All of these are direct quotes from the students’ learning reflective diary entries on the *Women’s Health Wiki*.

- **Acknowledging complexities in representations across contexts**

This describes the process wherein students start to recognise complexity and contradiction in how concepts and people are represented in different settings. In this case, the students focused on how this applies to the portrayal of gender in the media. The following quotes on the wiki most strongly exemplify where this learning process occurred:

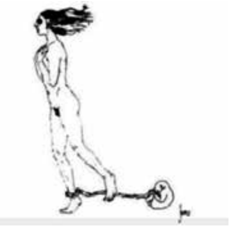
Women throughout the ages have been subjected to an image, which has created the ideal women and what should be expected of her. The advertisements don't just stop there; their images create an idealised expectation of the lifestyle and the conduct in which women 'should' be endlessly striving for.

We have to realise that the "supermum" is not the model who is photographed with the baby, it is the millions of mothers and women who look after their children day in day out

The 'Twilight' series not only brought us sparkly vampires and sexy werewolves but it also romanticized, what is in reality, an abusive relationship. There are numerous examples that prove the relationship is abusive:

- *Edward isolates Bella from her friends and family*
- *He drives recklessly with her in the car*
- *Threatens to commit suicide*
- *Controls where she goes*
- *Threatens to kill her*
- *Has his family babysit her*
- *Blames her actions for him not being able to control himself*

An untitled drawing by Fons Van Woerkom. In this picture, a foetus and umbilical cord are a ball and chain, imprisoning and immobilizing a desperate woman. In my opinion, this symbolises the urgent plight for equal treatment of women as working mothers in our culture.



- **Critical evaluation in real-world scenarios**

This theoretical category highlights the process wherein the students apply theory to evidence; they bring together new theoretical concepts and find examples of where these can be found in everyday real-world practice. The following quotes on the wiki most strongly exemplify where this learning process occurred:

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They found that mothers spend 40 minutes less time on 'leisure activities; with their children when their partners work weekend, fathers spend an extra hour with friends on leisure activities when women work on Saturday. It was suggested that this was due to women having more responsibility for household and care work. In addition they found that men spent an average of 18 hours and 20 minutes on housework while women spent 33 hours and 43 minutes.

Disordered eating is emerging as a norm in Australian society with 90% of 12-17 year old girls having been on a diet of some type. Drunkorexia is the new term I learnt from this week's lecture. It means disordered eating combined with alcohol abuse which was indicated to exhibit more risky behaviours such as unprotected sex and alcohol overdoes.

Statistics showed that up to 75% of DV reported to law enforcement agencies occur after separation of the couples, with women most likely to be murdered when reporting abuse or attempting to leave an abusive relationship, because the abuser thought that they have nothing to loose, and many many examples are seen in the everyday news include abduct children from mothers, murder, acid attacks, etc. which is quiet scary.

A study showed that delaying the first and second birth later in life among working and non-working women in most of European countries is positively linked with the decline in total fertility rate (Bratti & Tatsiramos, 2008). Lack of family friendly organisations, cultural influences and socioeconomic status are the potential socio-cultural factor producing a delay of motherhood in the most of European countries (Bratti & Tatsiramos, 2011). In Australia, a report showed that the percentage of first birth to women aged 35 and over is increased %10.2 in 2000 compared to 1990.

- **Reflective practice based on experience**

Students combine new theory and evidence and bring it back to their own experiences. This is a crucial part of constructivist reflective learning as the students seek and locate stories from one another and insights from themselves to apply their learning and ground it in a sustained new level of knowledge. The following quotes on the wiki most strongly exemplify where this learning process occurred:

The first time that I REALLY realised the consequences of women and advertising in the media and its effects on popular culture was after watching the documentary: "Killing us softly". … After watching it I realised that even though I thought I could resist the pressures and influences of advertising, I had been a victim.

For me, I found from this that above all, women are sexualised constantly and in more ways than I thought possible. Advertisements with violent images and submissive women, I never realised the influence this could have on popular culture.

I must admit, I am a 24 year old woman who previously would not identify myself as a feminist. The term feminism sort of scared me and had an associated passion and fire for women's rights which I simply could not relate to. It was not until this Women's Health unit that I have had the reason to question and research feminism and feminist theory and to then see past the stereotype I was only ever familiar with.

Though I haven't found any examples of gender discrimination within my workplace or any evidence of women that power trip when given higher positions it is impossible to forget the comments one may often hear when a woman is promoted to power.

Even more interesting is that I too seem to care about my appearance. What are people saying about my body? Do I pass the test of being adequate? If there is such a thing as the 'perfect female body', how do I match up?

- **Collaborative co-construction of knowledge**

This is where an interactive and continuous dialogue occurs wherein the learning processes are situated and developed for all those involved in the interactions. The following quotes on the wiki most strongly exemplify where this learning process occurred:

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*I really think your statement -**" I think that the perfect mother image that is constantly portrayed on the media made this woman feel inadequate as a mother and contributed to her mental health problems."** was absolutely spot on. In a majority, if not all baby adverts there is a happy, smiling, beautifully presented mother with her laughing and giggling baby. This is not a real depiction of motherhood…*

I quite agree with your entry regarding abortion. I personally think women are sometimes not given enough choice and I think it should be an individual choice.

I particularly found your week 10 entry about age and how it affects women very interesting. It's such a shame there is such a stigma around this, it's the society's perception that men grow wiser and better with age and women just get old.

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Wow, great entry. I really agree with your point, how much of what has happened to us as women has happened because we have let it?' I see so many young girls totally degrade themselves to try and impress the opposite sex.

- **Final reflection on the women's health unit and reflective diary practices**

Finally, highlights from the answers students gave regarding our questions about how the wiki affected or influenced their learning processes are collated and presented below. This is useful insight for anyone considering inserting a collaborative online reflective learning space into their under graduate curriculum.

I really enjoyed doing the wikis every week. I felt it was a great way to 'focus in' on a topic of my interest and to delve further into a topic relating to women's health. It gave me the opportunity to reflect upon my own opinions and critically analyse how this compared with the additional research I undertook to complete the wiki.

I really enjoyed having the weekly reflections. As the semester went on I found myself noticing little women's health issues on TV or on the internet or just in general out and about and I really enjoyed having a space to talk about it and to show how the unit was affecting how I viewed the world. I have even thought about continuing on with my weekly reflections on a tumblr or something.

It was a fun way to learn and very practical learning. I was able to pick something out of the lectures that I was interested in or wanted to learn more about which gave a sense of choice and being able to choose what we wanted made it good we would tailor the topics to our degree too.

There really wasn't anything I didn't like about the Wiki diaries – I thought it was a completely different assessment that allowed me to thinking and explore the coursework in an enjoyable way that related back to my own experiences and life.

But I actually enjoyed writing them. I enjoyed doing them because I thought that this was an opportunity for me to get my points of view out there. I also liked reading other student's entries, it gave me a different perspective as well.

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7. Theoretical model

Figure 1 presents the social constructivist analysis of reflective learning processes on women's health wiki diaries.

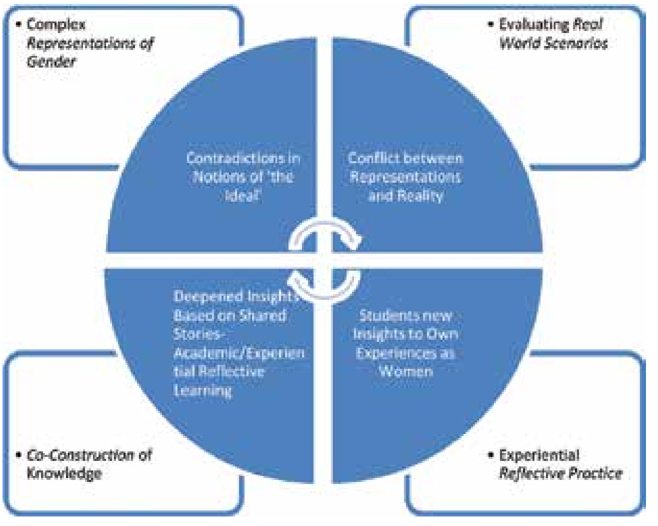

Figure 1. Social constructivist analysis of reflective learning processes on women's health wiki diaries, QUT Public Health Undergraduate Students.

8. Conclusion

An online collaborative space was sought to instigate communication processes between students that allowed them to (a) generate internal dialogue and reflection about what they heard in lectures and tutorials in Women's Health and (b) generate interpersonal dialogue and reflection between the ideas created by their peers in a bid to encourage a social constructivist pathway to sustained learning and critical thinking—all while developing their ICT skills. 'Wikispaces' was identified as a useful online tool to provide a 'thinking and talking space' for students to further develop the learning that had occurred for them within the context of the classroom. Importantly, we found that their learning was enhanced in four key areas as a result of the reflective diaries exercise. First, they developed a complex understanding of how gender is presented in the media. This complexity meant that they understood that agreements as well as contradictions between gender portrayals all contribute to the social construction of gender in any given social context. Secondly, they applied theoretical paradigms and new concepts to evidence from the literature, government sources and their own observations in 'real-world scenarios'. This gave them the opportunity to ground their critical thinking in concrete, scientific examples of the new concepts. Thirdly, they were given time, space and creative licence to apply both theory and evidence to reflect on how they had experienced this personally, or seen it happen anecdotally throughout their life course. Finally, they were encouraged to discuss diary entries with one another to 'compare notes' and provide feedback on differences and similarities in the learning processes. This final set of interactions is crucial in aiding a truly constructivist and sustained approach to learning that allows students to continue to travel with their 'learning tools' into new contexts wherein they can apply the same

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processes of critical thought to more obtain a more sophisticated insight to new phenomenon in future. The students all developed confidence in creating and using a wiki, including skills that involved embedding a range of online resources, media, music and videos into their individual wikis, and effective online communication. Overall, we highly recommend the use of wikis as a successful mechanism for reflective learning practices and the development of ICT expertise in undergraduate learning.

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New Educational Challenges and Innovations: Students with Disability in Immersive Learning Environments

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65219

Abstract

In today society, one of the most demanded challenges faced by the current educational system is the educational response to diversity in the various educational contexts. University lecturers are opening new lines of research focused on issues as social demand and current reality of produced new learning environments. The general aim of this study was to design learning environments using immersive virtual reality and evaluate improvements produced by this tool in relation to the difficulties show by the participants. From that point, an action plan was created to recreate school situations with a high degree of realism and interaction using IVRSystem. In this way, we want to obtain answers according to the dysfunctions of educational system to work with these students. This was done by a mixed design. On the one hand, a quasi-experimental methodology was used with a control group and an experimental group. On the other hand, direct and observation and applicative methodology made possible the development of educational intervention in immersive learning environments. The results obtained throughout these years have given a response to the initial problem-question raised: Can immersive virtual learning environments serve as a support tool for working disabilities of students, which have a visual learning style, such as students with autism spectrum disorders?

Keywords: learning environments, immersive virtual reality, autism spectrum disorders, technological systems, disability

1. Introduction

This chapter aims to meet one of the most demanding and complex challenges of the current educational system: the educational response to diversity in the various educational contexts.

Based on their research work, increasingly connected with the social demand and reality, university lecturers are opening lines of research, which deal with these issues. In that sense, our proposal consists in the implementation of new learning environments through immersive virtual reality (VR), from an interdisciplinary (technological and pedagogical) work oriented to face diversity, associated with disability, of students with autism spectrum disorders (ASDs) in this case, and seeking to achieve the following overall aim:

To design learning environments for the purpose of recreating school situations by means of immersive virtual reality and assessing the improvements brought by immersive virtual learning environments with regard to the difficulties posed by the participating students.

After an initial section dedicated to reviewing the literature and all the research works on virtual technologies, the second section provides a description of the most important tools used to design immersive virtual environments as well as the structure of the software developed. An analysis is subsequently performed about the contributions, which can be used for the intervention with students who have deficits in communication skills from immersive virtual reality—as opposed to the desktop one. The third section lists the innovations and works carried out by authors based on the utilisation of the aforementioned technological tool. In addition, the present work will finish with a number of proposals for improvement meant to ensure further progress in this area from the results obtained and their educational implications, along with the bibliographic references used.

2. Review of the literature on virtual reality

Virtual reality (VR) has been used to plan, practise and implement behaviours and to observe the responses within a computer-generated virtual context. These systems offer a three-dimensional representation of real, controlled and safe environments that can be executed in a repetitive manner

A number of early works [1–8] already highlighted the advantages of virtual reality as a tool to create predictable learning environments. Other subsequent and more recent works [9–24] have verified the advantages of virtual reality as a support and help tool for students with deficits in communication, social and emotional skills, and more precisely for students diagnosed with autism spectrum disorders (ASDs).

An aim is consequently set at this stage to undertake a review of all the research carried out on virtual technologies and the advantages that they bring to students with communication difficulties. Szatmari et al. [25] already started in their first research studies that the utilisation of virtual reality with ASD students made it possible to obtain great academic achievements in a relatively independent way. Along the same lines, aspects characterising VR such as the design of a strictly controlled environment and a highly individualised intervention are the advantages considered by [26] for its use with students who have communication problems.

This review helps to confirm the increased possibilities of this virtual tool, which can be used to teach ASD children to improve their understanding of other people's mental condition,

http://dx.doi.org/10.5772/65219

authors [3, 5, 27–29] even claim that children with ASDs tend to have normal cognitive skills and do not show delays in their language. Authors [8, 30] advocate an intervention through computer-assisted learning based on presenting the information in such a way that the potential confusion and the anxiety induced by the manifold sources which characterise the real world for such students can be reduced. Research following the same approach was undertaken by Brown et al. [7], who designed a city-like virtual environment with different buildings, which the user had the chance to explore, simultaneously putting into practice the various skills of everyday life.

All the research works mentioned so far, which were based on desktop virtual environments, together with others [3, 27–29] pursue the aim of teaching children with ASDs to achieve a better understanding of other people's mental condition. This perspective serves to justify that desktop virtual environments provide the best possible method to train social skills and, as argued by Parsons et al. [31], the ability to understand other people's behaviours, as well as the interpretation of language in the terms utilised by the speaker, can be trained by means of computer-based tasks in which it is possible to monitor the level of input stimuli received by the user, and sharing a series of characteristics with the real world through the use of sophisticated graphics and design. These types of learning can even allow the transfer of learned skills.

The research carried out in the 2000s reinforced a positive response to virtual environments on the part of users, insofar as the use of avatars may provide them with the ability to predict emotions [32], as well as show that they remembered the knowledge acquired during the sessions [33]. These authors see VR as an additional tool for the utilisation and training of social skills in the classroom and perhaps for an increased use of the already existing methods and investigations.

Another of the aspects characteristically associated with VR utilisation has to do with the fact that it offers a safe working environment for students with communication problems and that a need existed to achieve a generalisation of the learned skills [34]. Along these lines, Mohamed et al. [35] focus their research on the use of platforms for the design of environments. The model designed revolves around tasks to be worked on within a scenario where children had to follow with their eyes a path that the environment indicated to them and any error resulted in the system making a noise. It was possible to check that, thanks to virtual environments, children managed to improve their attention, even though the virtual model designed could not be validated.

The utilisation begins with a kind of social stories in virtual environments combined with video modelling for the purpose of enhancing and developing ASD students' conversation skills [36]. A bet is also made on a VR understood as attractive and easily administered sophisticated training packages aimed at promoting learning through different contexts [37], continuing with a proposal to make virtual environments more realistic, reproducing the great complexity represented by the human face and achieving the most complete possible reading of the user's features [38]. These authors used the TEACCH method, which includes large quantities of visual materials, and each area was structured in such a way that it had some visual information as well as the instructions related to the beginning and the end of the task.

The progress made in the research initiatives implemented shows an absence of adverse psychological responses to virtual environments by students with ASDs, exactly as it happens with typical development children [20]. Furthermore, when the environment has greater realism, children pay much more attention to the contents presented. These authors also insist on the need for animations to be adapted to children's preferences and for virtual scenarios to be more realistic so as to interest children to a far greater extent in their contents. Their findings ultimately lead them to point out that generalisation problems appear with such environments and that, in certain situations, the user is unable to interpret the avatar's intentions.

Advances are made in the incorporation of another tool with VR, robotics in virtual environments, as an element that can improve ASD students' social skills, thus seeking to monitor the child's look and the social interaction distance. It became obvious that ASD students exponentially increased visual contact at the moment when the robot came closer to them, unlike what happened with the control group [39], but without forgetting that any variation whatsoever in the virtual environment generated changes in the child's psychological and social ratios. Another line of research advocates the identification of VR as a platform for social discussion and interaction with other children, which offers the possibility of achieving improvements in the social skills of ASD students [23].

It was subsequently checked in some results that what had been worked on in virtual reality could be transferred to the real world if highly structured procedural tasks with rules were used, while at the same not forgetting that these programmes had to be suited to the user's specific characteristics and individual capabilities [40]. Other research studies [41] applied virtual reality for ASD students as a tool which can facilitate the real-time recognition of emotions (recognising the emotions of others as well as their tones of voice); the theory of the mind (recognising and responding to other people's thoughts and wishes); and the capacity for conversation (initiation, maintenance and closing)—obtaining high scores in recognition and the theory of the mind thanks to VR utilisation.

Likewise, the paper by Lorenzo et al. [42] suggests a set of protocols with immersive tasks to train social skills. The results confirm that certain problems arise in their execution at first but also that a considerable improvement as well as a certain transfer of the learned skills take place as those tasks are gradually performed in the immersive environment. Recent research works, such as the one undertaken by Wallace et al. [43], have stressed the need to provide environments with greater realism, since that would allow children with ASDs to perceive the negative responses, which are sent to them by the environment, thus helping them to enhance their social skills. The current study performed by Lorenzo et al. [44] constitutes an advance with respect to what has hitherto been reviewed; it stresses the fact that the immersive virtual environments designed to work on emotional competences with ASD students have permitted a high degree of interactivity, along with a chance for the training of social roles which are represented in emotional scripts prepared like social stories. Their findings have similarly revealed medium rates for the transfer of learning from the virtual environment to real situations. Didehbani et al. [45] equally used three primary domains to work with virtual reality amongst students diagnosed with ASDs: recognitions of emotions, social attributions and attention and executive functions. The results obtained show an improvement in recognition of emotions, social attribution and the analogical reasoning of the executive functions which are largely due to the social-interaction-related advantages brought by virtual reality.

3. Virtual reality systems developed in learning environments

This section is going to offer a review of possible software and hardware architectures used to work with students, on this specific occasion, with students who have problems regarding communication and social skills as well as executive functions, as is the case of students with ASDs.

A set of tasks are presented in a learning environment where children with ASDs must respond to instructions given by a computer or by a/some person/s [46]. The results obtained by these authors show that the increased level of motivation and the reduction of inappropriate behaviours, which had been observed during the instruction stage, is unfortunately not accompanied by a significant improvement in learning. Along the same lines, an interactive computer program is utilised to teach ASD students reading and communicative skills [47]. Such virtual types of learning reflect improvements in the child's vocabulary during the training period and a high degree of motivation and interest towards the planned tasks as well.

One of the first bets on immersive virtual reality can be found in the work of Szatmari et al. [25], who implemented a virtual immersive reality where children wore a helmet equipped with two video cameras in front of their eyes—and the point of view changed when the children moved. The learning tasks focused on the children's learning to cross the street in such an immersive environment. That required a previous process of adaptation to the environment. The results show how children learned to cross the street, but a number of problems arose when the environment parameters were modified. To those advances must be added the contributions made by Strickland [4], in whose work children could use a pair of 3D vision glasses and a low-cost tracking system with their PC in the classroom. This made it possible for children to learn to know what to do in each situation and to be able to take that learning to the real world right away.

Other systems used were: a dialog program by means of bubbles where the user can think and talk to the main characters of various social situations [48]; virtual desktop environments aimed at allowing ASD children to have a working environment where they can learn to organise the tasks that these children must do at home after returning from school, with two modes: the 'training' mode, very passive and in which the child had to familiarise with the environment; and the environment and mode referred to as 'late', where the child carried out the activities and navigated and interacted with the 2D and 3D objects present in the environment [49].

Continuing with desktop virtual reality, computer games are proposed with eight problems related to social situations that the user had to solve, additionally suggesting alternative solutions [50]. Ten training sessions alternated with six test sessions were developed in the previous works. In the training sessions, the tutor explained which specific solutions corresponded to the different situations raised. The findings showed improvements in the utilisation of problem-solving techniques. Following this same approach, the paper by Cheng et al. [51] suggests using a software called KidTalk, which allowed the child to interact in very rudimentarily represented real situations where the child participated through a text chat. The results obtained are quite satisfactory, even though a recommendation was made both to broaden the sample and to extend the intervention time.

Desktop virtual reality thus clearly seems the most often used for interventions with these students, and another example can be found in its utilisation by Leonard et al. [52] to work on decision making: knowing what to do when the time comes to make a choice (a place which was a café or a bus). The scheme programme is complemented with some previous sessions during which the children watched a video of the real situation on which they had to work in the virtual environment. The design of a three-dimensional animated head called 'Baldi' additionally served as a kind of avatar, which provides a realistic and visible feeling of realistic speech through which children with ASDs could learn vocabulary [53]. It is checked that vocabulary learning takes place, its generalisation to highly structured situations being largely due to the avatar and not only to speech.

The work of Pioggia et al. [54] enriches virtual environments with the insertion of a new element: the use of a robot to practise social and emotional skills. In the first part of the session, the same as in the studies performed by Leonard et al. [52], the children viewed several real situations, after which they interacted with an android and their behaviours were recorded in another room. Along the same lines, Moore et al. [55] use desktop virtual reality as a collaborative environment for the recognition of emotions. Tasks such as the recognition of what has been expressed by the avatar, the identification of the emotion suited to the context and the identification of the context according to the emotion expressed were used to that end.

It also becomes obvious that the school environment reality increasingly merges into desktop virtual reality. This is illustrated by Vera et al. [56], who designed a whole school to be used with ASD students, to perform all the tasks carried out therein, taking into account their realism, interactivity and adaptability to the difficulties that these children pose. These authors express a certain degree of imaginary play when it comes to the responses given. Herrera et al. [57] subsequently added two touch screens similar to what immersive virtual reality might look like, with the aim of working on imagination and symbolism in the social situation of going to a supermarket. The programme is complemented with a number of tests meant to assess the improvements achieved after carrying out the intervention. The results show satisfactory improvements amongst students with ASDs. Taking up the work [26], interventions are performed in decision making, as exemplified by learning to cross the street, but increasing the number of users; a positive transfer of learned skills is verified [10].

Another of the software programs used is the iSET desktop application, which permits to record emotions in a variety of social situations so that they can be subsequently tagged, Madsen et al. [58] along with the creation of a laboratory virtual environment where the child wears a cap with a receiver that sends the emotional information to a website; likewise, the child uses a glove which has as its aim to generate different pressures on the hand [59]. Other authors [24] resort to desktop virtual reality, reproducing a virtual class and a scene outside the classroom with the aim of training social competences: recognition and expression of feelings, non-verbal behaviours, visual contact and a suitable way to listen to others. Significant improvements become evident in the results obtained with this program.

The utilisation of the FEW program based on the film Alice in Wonderland for the purpose of detecting the possible changes experienced by the character as the story progresses [60], as well as the Mind Reading system through a library of emotions [61], together with the FaceIT software, by means of which users identified the changes operated in specific facial expressions [62], complete the contributions of the desktop virtual reality oriented to the development of emotional competences in students with ASDs.

The paper by Wallace et al. [20] revolved around the non-utilisation of any type of device, such as glasses or the like. Two working groups were formed: one with ASD children and the other with a control group. Users worked in three scenarios: in the first scenario, the user drove along a real road and all the other cars drove in the opposite direction, the children observed without interacting; in the second scenario, the child will act as the observer of a social situation and will have to react to it; and in the third scenario, the child will have to walk along the corridor of a school, thus being able to witness the different activities in progress. The innovative works of these authors, based on their results, and despite expressing a good connection between virtual and real images, reveal problems linked to interaction and context generalisation.

Nevertheless, as an element of support for desktop virtual environments, Bevilacqua et al. [63] proposed in their paper the utilisation of a Webcam automatic algorithm to measure levels of disability depending on the expression of emotions. Other new aspects introduced to improve such programs focus on using avatars, the Computer Expression Recognition Toolbox (CERT) facial recognition library and the Emotion Mirror system [64], even though a number of problems appear with regard to the contextualisation of emotions, insofar as the life experiences presented in desktop virtual reality do not have the same degree of interaction and realism as immersive virtual.

Amongst the first bets on immersive virtual reality stands out the work of Lorenzo et al. [42], who advocate the use of immersive virtual reality incorporating a series of improvements such as the collection of data not only to evaluate students' behaviour but also for its training and potential improvements, as well as the function of system sensors when it comes to determining if the task performed was properly developed in the virtual environment, which permits to know the extent to which social skills and executive functions have improved. This line of work initiated by the aforementioned authors was extended with the study undertaken by Matsentidou and Poullis [65], who designed a cave in immersive virtual reality by means of four HD screens, four projectors and cameras, unlike the previous authors, who used an immersive L. These authors ultimately wanted the virtual reality cave to be effectively used with ASD children, checking whether or not children were able to benefit from the application of the acquired knowledge to their real life. Unlike what happened in the previous case, the system proposed was not tested and should be implemented in non-school-related situations.

Amongst the most current papers dedicated to the new advances in virtual reality stands out the one by Zeng et al. [66], where immersive virtual reality serves to develop the attention of ASD students, something which had not been proposed in this type of system yet, but had actually been carried out in desktop virtual reality. As for new research initiatives, the work undertaken by Lorenzo et al. [44]—which continues along the lines of investigations already initiated with immersive reality—transfers their contributions to the training and development of tasks such as the recognition of emotions amongst students diagnosed with ASDs. These authors prepared social scripts as well as situations in the style of social stories that these students had to identify and solve in immersive learning environments.

Another of the contributions to immersive virtual reality has recently been made by Newbutt et al. [67] with the aim of simplifying the installations utilised in the classical immersive virtual reality systems, choosing the OCULUS glasses—an HDMI device which, unlike those previously used by Strickland et al. [26] and Strickland [4], needs no cables. Environments are designed in a personal computer that provides a stronger feeling of immersive thanks to its being equipped with a set of loudspeakers—which the 3D glasses used by Lorenzo et al. [44] did not have. The authors mentioned above point out that the ASD children readily accepted the OCULUS glasses to work and were additionally able to solve the tasks proposed successfully.

4. Virtual reality systems developed in learning environments

The bet on immersive virtual environments for students who have a deficit in communication and social skills, more precisely, who suffer from ASDs, is supported on two basic premises: (a) the characteristics of their cognitive style, which requires an explicit kind of teaching by means of visual aids as well as a highly structured environment and (b) the possibility to exploit the advantages that such environments bring us in terms not only of interacting, instructing and practising quasi-real school situations but also of transferring the practised learning to the school environment [42]. The design of highly structured virtual environments can constitute an educational innovation as well as a learning strategy that can be raised as a challenge and an innovation to be applied with disabled students, and more specifically with ASD students, characterised for being essentially visual learners who find it easier to retain and assimilate visual information.

The basic research question of this study—Can immersive virtual environments serve as a learning tool for disabled students with a visual cognitive style?—was taken as a starting point to formulate the following specific aims:

-To design new immersive learning environments to train skills associated with the executive function and the improvement of social and emotional competences with ASD students.

-Utilising Immersive Virtual Reality (IVR) as a personalised support tool within a structured visual environment.

-Evaluating the level of generalisation of the acquired learning to the school environment.

http://dx.doi.org/10.5772/65219

4.1. Design and procedure

The specific aims set provided the basis for an action plan through an immersive virtual reality system used to recreate school situations with a high degree of realism and interaction with the user seeking to obtain the responses desired according to the dysfunctions faced. This was done by means of a mixed design: on the one hand, a quasi-experimental one with a control group and an experimental group; and, on the other hand, an applicative direct and systematic observational methodology that made it possible to develop the educational intervention in immersive learning environments. The methodological design used implies a change of paradigm, insofar as the aim sought is not to evaluate dysfunctions but to carry out an intervention with them, additionally assessing the extent to which they improve through the use of immersive learning environments. These are the stages implemented during the last few years:

-Initial stage. Problem-questions are proposed as a starting point.

-Planning and design stage. The attention is focused on the design of immersive environments as well as of the information collection instrument. These immersive environments must permit not only the identification and recognition of disabilities but also their training and improvement.

-Implementation stage. Users are made to practise and experiment by means of immersive virtual environments.

-Analysis stage. It consists in the study and examination of the results obtained and their educational implications, assessing the improvements provided by immersive virtual environments regarding disabilities in comparison with desktop virtual environments.

4.2. Our immersive environment

The immersive environment used [42] was created through the arrangement of two screens in an L shape where the different scenarios were projected with a wide-angle lens in order to reduce the projection distance—and therefore the space requirements too. The user's immersive is achieved using a pair of active glasses of the brand Stereográfics (CristalEyes model), which allow users to have a 3D feeling as something real in front of their eyes. The user additionally wears a cap with light-emitting diode (LED) that will be detected by means of infrared cameras. A Mikrotron MC1324 GigE camera was also used for the detection of the child's expressions in the immersive environment. The addition of loudspeakers and a high-fidelity amplifier permits to hear any kind of voice, noise or song according to the needs, which may eventually arise in the virtual environment. Thanks to the HP Z800 Work Station—which includes all the necessary software components—it will be possible to generate the scenarios, distributed to both projectors through a video signal, showing their content on the screens. The system is completed with the monitor, the immersive virtual reality generation module, the Vizard program and the data capture module, along with the visual control performed with the manipulating robot. Furthermore, a voice recognition system served to check when the user was carrying out the task, and whether the volume and intonation of the voice were suited or not to the situation presented. **Figures 1** and **2** provide a sample of the elements shaping the system described above.

By way of example, **Figures 3** and **4** show some of the immersive virtual environments created.

Figure 1. Elements of the virtual reality room. (a) and (b) Projectors, (c) 2 screens in an L shape, and (d) virtual reality glasses.

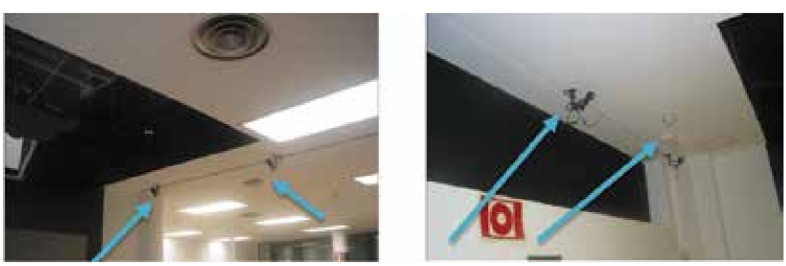

Figure 2. Positioning system.

4.2.1. Participants

The study undertaken through several stages [42, 44] had students diagnosed with ASDs from the primary and secondary educational stages as its participants. The control group included students who were working in school centres that applied the traditional support methodology

http://dx.doi.org/10.5772/65219

Figure 3. Immersive environment: playground of a primary education school.

Figure 4. Immersive environment: playground of a secondary education school.

used to deal with their difficulties in social skills and executive functions such as emotional competences; in turn, students with similar characteristics formed the experimental group, but their intervention took place in the immersive learning environments designed. The sample was shaped in the first stage with 10 primary education students from public schools located in the city of Alicante (Spain) and a second group of 10 students from secondary schools also located in Alicante; and in a second stage, with 20 randomly chosen children who had to carry out the tasks in the IVRS and a second group, the control group, 20 children, chosen randomly, will carry out the tasks in the VR.

4.2.2. Instruments: immersive learning tasks

Taking the aims established as a reference, priority was given to making a proposal of activities in the immersive learning environment. These were the instruments designed:

-First stage. The focus on work with executive functions and social skills led to design: the TEVISA support task protocol; THE PIAV avatar instructional protocol; and the monthly interview with the teachers of the schools while the aforementioned protocols were implemented. This protocol was used to suggest the students a set of tasks referred to executive functions as well as social competences, and associated with situations at a classroom level in which disabilities were present. The implementation of immersive tasks followed the two-step process described below:

a. Previous task. Identifying the situation (space, avatars and materials); description of the task to be performed; task instructions and self-evaluation.

b. Support task. Identifying the situation (space, avatars and materials); following the instructions and carrying out the task: answering the questions about the task performed.

An evaluation using the PIAV protocol took place while the tasks described above were carried out: body motor coordination control; voice control; look control; attention control; and empathy control. The discussion groups created by the participating teachers on a monthly basis assessed the evolution of students' behaviour in the school tasks, which resembled those undertaken in immersive environments.

Figure 5. Student from the secondary educational stage performing one of the social stories in the immersive virtual environment.

-Second stage. Focused on the identification, training and development of emotional behaviours amongst students diagnosed with ASDs. A script of emotional tasks in the form of 10 social stories was designed for the purpose of identifying the emotions implicit in those different social stories and the training of appropriate emotional responses when facing the social situations posed. The students had to identify what the avatars did, where they were and how they felt in the situation which arose, after which attention was paid to the management and training of the situation. The control group performed the tasks based on the social stories in the desktop virtual environment, whereas the experimental group did so in the immersive virtual environment. **Figures 5** show one girls carrying out the immersive tasks with social scripts.

4.2.3. Results and conclusions

The results obtained throughout these years [42] have given a response to the initial problem-question raised: immersive virtual learning environments can serve as a support tool to work on the disabilities of students who have a visual cognitive style—as is the case of students with ASDs.

During the first stage of our study, and even though students showed some confusion at the beginning of the sessions when it came to following task instructions, it was checked that they improved the understanding both of the actual tasks that they had to perform and of the instructions to do so. Despite the absence of high percentages (scores) for Response Category No. 4—which corresponds to tasks being carried out at a highly acceptable level—it became clear that the tasks were acceptably performed even if some confusions might appear. Amongst the data confirming the internal consistency rates for each one of the virtual blocks and environments created in the application of the TEVISA task protocol stands out the fact that reliability rates range between 0.68 and 0.91. As for the results obtained by both primary and secondary school students, overall they show a gradual but significant increase in students' behaviours in the different PIAV blocks, and even though the maximum values were not reached at the end, an improvement in the behaviour of the students involved was empirically verified [42]. The findings additionally reveal a gradual but relevant reduction of inappropriate behaviours as the intervention sessions are undertaken in immersive environments. The results obtained in the school context by primary school students show an average 2.23 out of 4 in their initial process of learning generalisation from virtual environments to the classroom, whereas secondary school students' average in this respect is situated at 2.5 out of 4. Averages above three are eventually obtained as work develops in the immersive environment. The participating teachers express the average progress achieved and applied in the classroom context.

As verified by the authors [44], the findings in the second stage of the present study show emotional behaviours increasingly suited to the situations proposed in the emotional protocol tasks, along with a significant improvement obtained by the students who worked in the immersive virtual environment compared to those who did so in the desktop environment. Hence, the confirmation of the higher degrees in the resolution of emotional responses in the immersive environment than in the desktop one, even though no significant differences appeared in the desktop control group with respect to the immersive one at the beginning of the sessions.

From the very beginning, the present paper advocates the use of educational innovations coming from virtual technologies applied to disabilities. Our suggestion is to keep moving ahead and to extend the implementation of immersive virtual methodologies to other types of disabilities with the aim of achieving a standardised use of such technologies within the dynamics of the teaching-learning process.

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Chapter 8

MOOCs in Higher Education

Sung-Wan Kim

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/66137

Abstract

MOOCs have been the major issue in higher education worldwide since 2008. Frankly speaking, there are clear pros and cons of moving into MOOC-based education. This chapter deals with the pedagogical utilization and limitations of MOOCs in higher education. Through literature review and websites surfing related to MOOCs, expansion of MOOCs, instructional strategies in MOOCs, functions of platform for MOOCs, development of a MOOC, and future of MOOCs are summarized, analyzed, and discussed at the aspect of pedagogy. Based on the analysis, some recommendations are suggested for the success of MOOCs.

Keywords: MOOC, higher education, e-learning

1. Introduction

During last years, MOOCs, or massive open online courses, have been at a furious pace (**Table 1**). MOOCs are a new type of e-learning class, which are consisted of short video lectures, computer-graded tests, and online discussion forums. They are usually for free and sometimes by fee. MOOCs have been positioned as hybrids of previous attempts at online distance education opportunities, such as Open Coursewares (OCWs) and Open Educational Resources (OERs) [1]. However, in spite of widespread adoption, the instructional quality and business model of MOOCs are still under the question. Need of adequate instruction and business strategies for utilizing and operating MOOCs in higher education has been highly required.

This chapter summarizes the present status of MOOCs in higher education, theoretical frameworks underpinning the pedagogical approach instantiated in MOOCs, and education research contributing to the design, implementation, analysis, evaluation of MOOCs and to suggest implications and strategies for operating MOOCs.

USA	Europe	Asia-Oceania
Cousera (2012): 1905 courses	FutureLearn (2012, UK): 351 courses	KMOOC (2014, Korea): 18 courses
edX (2012): 975 courses	Open Classrooms (2007, France): 25 courses	JMOOC (2013, Japan)
Udacity (2012): 141 courses	OpenHPI (2012, France): 30 courses	Xuetang (China)
Peer to Peer Univ. (2009)	iversity (2013, Germany): 93 courses	NPTEL (2006, India): 96 courses
NovoEd (2013): 77 courses	ALISON (2007, Ireland)	OpenLearning (2012, Austria)
Canvas: 345 courses	MiriadaX (Spain): 168 courses	Rwaq (2013, Saudi Arabia)

Table 1. Main MOOCs in the world (2016).

2. Big-bang expansion of MOOCs

MOOCs for higher education have rapidly expanded in the USA, Europe, Asia-Oceania, etc., since 2008: Cousera and edX in the USA, FutureLearn (UK), iversity (Germany), MiriadaX (Spain) in Europe, KMOOC (Korea), and OpenLearning (Australia) in Asia-Oceania.

The number of students who have signed up for at least one course surpassed 35 million in 2015, which is higher than an estimated 16–18 million from the previous year [2]. In 2015 (**Table 2**), Coursera accounted for nearly half of all MOOC students (17 million) and 35.6% of MOOC courses. edX is the second-ranked provider with just over 18% of all courses. Canvas network comes in third with 6.92% of courses, followed closely by FutureLearn at 5.68%. FutureLearn, which is grown by 275% with an estimated user base of 3 million, is now the third-ranked provider by enrolment. The percentage of courses in English decreased slightly from 80% in 2014 to 75% in 2015. It is caused by the growth of France Université Numerique (FUN) and the Spanish platform Miriada X.

2.1. What brings the very fever of MOOCs?

First of all, MOOCs promise to provide free education, unlimited participation, and open access for anyone. That is, they aim at democratization of education. The registered learners, who appear to be broad, diverse, and nontraditional, can get the free opportunity of participating in the lectures which famous professors in top universities give online. Supporters

MOOC service	Coursera	edX	Canvas	FutureLearn	Miriada	France Université Numerique
Market share	35.6%	18.1%	6.92%	5.68%	3.66%	3.33%
MOOC service	**Udacity**	**Open Education**	**Rwaq**	**Diversity**	**NovoEd**	**Others**
Market share	2.95%	2.12%	1.83%	1.78%	1.63%	16.4%
Source: Class Central.						

Table 2. Provider market share by courses offered (2015).

http://dx.doi.org/10.5772/66137

of MOOCs consider them as a means of democratizing access to education and as promising new insights into teaching and learning from analytics on tens of thousands to millions of students [3, 4]. Many people are sure that MOOCs will reduce the costs of teaching and they are efficient from an economic perspective. Second, many universities in the world scrambled to join in the new movement of MOOC. They did not want themselves to be left behind, compared with other top-leading universities. And governments from many countries are eager to participate in the paradigm shift of MOOC. For example, French government and Korean government have, respectively, backed France Université Numerique and K-MOOC.

2.2. What is the business model of MOOCs?

At this time, no convincing business models exist [5]. The sustainable business model has been a major challenge for MOOC providers. The envisioned premium services generating income may include learner's pay for certificate and secure assessments, company's pay for applicant screening and employee recruitment, learner's pay for human tutoring or assignment marking and tutors supporting forums to operate more successfully, hotline services to support learners experiencing problem with content and technical issues, selling MOOC platforms, sponsorships, tuition fees (e.g., the experiment of computer science dept.) [6].

The industry has an unusual structure, consisting of linked groups including MOOC providers, the larger nonprofit sector (e.g., the Bill & Melinda Gates Foundation, the MacArthur Foundation, the National Science Foundation, and the American Council on Education), universities, related companies and venture capitalists (e.g., Kleiner Perkins Caufield & Byers, New Enterprise Associates and Andreessen Horowitz).

In 2015, major MOOC providers are stepping back from offering free certificates in favor of paid credentials and courses for credit [2]. A number of examples of alternative credentials (e.g., edX's XSeries program, Coursera's specializations, and Udacity's Nanodegrees) appear.

The major MOOC providers are increasingly focused on fee-based credentials, including alternative credentials but also more traditional academic credit options and full degrees, as the foundation of their revenue models.

2.3. Are MOOCs reliable?

MOOCs have generated underestimation and skepticism as well as hype worldwide. The main concerns about MOOCs are as follows [5, 7]: the absence of serious pedagogy, homogenization and depersonalization of education, corporate influences on the academy and lack of attention to the findings from decades of research on distance education. In particular, the issues of instructional design quality including learner motivation and support are considered very serious, which are the main reason of low rate of completion in courses. One study summarized the most commonly cited reasons [8]: MOOC takes too much time, assumes too much knowledge, is too basic and not really at the level of world leading universities, provides lecture fatigue, poor course design, clunky communication tools, bad peer review, and hidden costs (e.g., professor's expensive textbook, paying for a feature designed to prevent cheating on exams). Learners in a MOOC can be degraded to the shopper for courses.

Professor's burden in teaching should be also treated at the same level with the above problems. The most frequently cited reason for professors' participating in MOOCs is a desire to increase access to higher education worldwide. But the big instructional burden which the professors must take for lecture preparation is beyond that in face-to-face class. A lecturer spent more than 100 hours on recording online lecture videos and doing other preparation before starting MOOC class and he or she spent 8–10 hours a week on the course including online activities such as discussion forums [9, 10].

Up to now, most of analyses on MOOCs focused on economy (e.g., productivity, cost) and technology (e.g., platforms, automatic grading). More theoretical groundings and qualitative and quantitative data are still requested for evaluating whether MOOCs are effectiveness and efficiency in educational perspective.

3. Instructional strategies in MOOCs

Do MOOCs play a pedagogical role well? Why is this question important? Because educational quality can ensure the success of MOOCs. MOOCs are at a retrograde step, because it is as if distance learning had just been invented and nothing was known about the need for quality in instructional design and learner support [11]. High noncompletion rates are related to the issues of quality, sustainability, and pedagogy. Most registered students are shopping around MOOCs. They intend to explore the topic rather than complete the course. Siemens [12] suggested that the whole idea of an educational course needs to be reconceived from the traditional, closed group, highly structured course, where students are dependent on tutors, to open networks of self-directed learners.

In this section, some suggestions on instructional strategies in MOOCs are provided in order to solve the problem of low completion rates, usually lower than 10%.

3.1. Customizing a MOOC for satisfying learner's need

As MOOCs have evolved, two distinct types of MOOCs appeared: cMOOC or connectivist MOOC (e.g., P2PU, Udacity, Open Learning), xMOOC or eXtended MOOC (e.g., Coursera, edX)). cMOOCs are based on principles of connectivist pedagogy or the theory of connectivism, which argues that learning processes need to be carried out within communities and networks of learners in order to increase their knowledge by making connections and interacting with the knowledge community [13]. Instructional design approaches in cMOOCs attempt to connect learners to each other to answer questions and/or collaborate on joint projects. cMOOCs support collaborative dialogue and knowledge building [14]. Learners are increasingly exercising autonomy regarding where, when, how, what, and with whom to learn. To do this, they often select technologies independent of those offered by traditional courses. Utilizing blogs in cMOOCs can give students a "social presence" [15], and can be a medium for connection, self-expression, self-indulgence, and rich and critical distribution of information [16]. Five possible challenges can be suggested for cMOOCs [10, 17]: user-created content may make learning environment chaotic; digital literacy is required to utilize the online materials; the time and effort are needed from participants; once the course starts, students reshape and reinterpret, so that instructors have the difficulty of controlling the course trajectory; participants must regulate their own study plans and contents and set their own goals. The course will take on its own trajectory.

xMOOCs, the content-based or professor centric MOOCs, "reflect a more traditional learning approach of knowledge duplication through video presentations and short quizzes and tests" [18]. They employ elements of the original MOOC, but are, in effect, branded IT platforms that offer content distribution partnerships to institutions [19]. The instructor is the expert provider of knowledge, and student interactions are usually limited to asking [10]. More recently, it has been suggested that the distinction between these MOOC variants has become increasingly blurred such that "what goes on in any given MOOC is no longer clearly determined by its 'x' or 'c' status" [20]. And there have been calls to abandon the MOOC acronym in favor of new titles that more accurately capture the particular design and purposes of specific courses: hMOOC (hybrid MOOC), MOOR (Massive Open Online Research), MOOL (Massive Open Online Lab), DOOC (Distributed Open Collaborative Courses), POOC (Participatory Open Online Courses), and SPOC (Small Private Online Courses) [21]. Up to now, most of MOOCs are a type of xMOOC. Instructional activities in MOOCs need to be varied for satisfying learner's need.

3.2. Motivating learners

Less than 10% of the students who sign up typically complete the course. Most participants participate peripherally. Some students did not care whether they could complete a course or receive a certificate. Instead, they wanted to learn something based on specific needs. The most basic solution to the problem of poor completion rates is to motivate the learners to participate in the activities of MOOCs. Clow's model [22] is useful for motivating MOOC's learners. He creates the funnel of participation metaphor to describe the activity and completion rates in MOOCs. This funnel is defined as awareness-registration-activity-progress and is characterized by being similar to the AIDA (awareness, interest, desire, action) marketing funnel where attrition occurs through the stages of product awareness, interest, desire, and action. Howarth and his colleagues [23] extended Clow's model [22] by adding "student completion" to the end of the funnel (**Figure 1**).

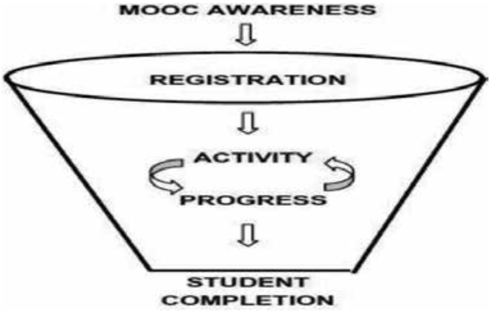

Figure 1. Funnel of participation. Source: Howarth and his colleagues [23].

To achieve registrations, awareness (attention) of their product should be created first through interest. Simply put, MOOCs should be perceived as being better than the tool or practice it replaces. Rogers [24] identified six relative advantages: economic profitability, low initial cost, decreased discomfort, social prestige, saving in time and effort, and immediacy of reward. The absence of cost is cited as a major reason for MOOC enrolment [22]. Value judgments on the basis of low price are clearly a motivator.

3.3. Identifying the factors for adoption of MOOCs

What are the main factors which affect the adoption of MOOCs? For identifying them, studies about factors that determine persistence in and dropping out of distance education will be helpful. The findings of Kim and Park [25] classified the factors into four categories: learner's characteristics, goal commitment, academic environment, and social environment on the basis of Kember's model of dropouts from distance education. Rogers [24] classified variables determining the rate of adoption into five attributes: perceived attributes of innovations, type of innovation-decision, communication channel, nature of the social system, and extent of change agents' promotion.

Al-Raimi [26] found that the intention to continue using MOOCs is significantly influenced by perceived reputation, perceived openness, perceived usefulness, perceived, and user satisfaction and "perceived reputation" and "perceived openness" were the strongest predictors. The cost of "free" may be too high in online education because it is threats to the economics of tuition-dependent educational institutions.

4. Functions of Platform for MOOCs

Once we decide to start some courses and consider a MOOC. Which tool will you use to operate the course? Swope [27] analyzed the main functional difference among five main MOOCs (**Table 3**).

A MOOC platform is first and foremost a branded website promoting courses based on a common learning management system (LMS). A MOOC is different from existing e-learning course in that it is characterized as open environment, free access, unlimited group, and emphasis on the learning process. So a MOOC platform must be different from the existing e-learning platform, or LMS and LCMS. What do most MOOC platforms have in common? They have common functions of technical hosting and publicity. Course developers utilize MOOC platforms in order to operate their content and learning environments including forums, quizzes, exams, peer to peer assessment, etc., and MOOC platforms also contribute to the visibility of the courses on their site [28].

First of all, let us see the open edX platform which powers edx.org and many other online education sites. This platform contains the learning management system (LMS), course authoring applications, course discussion, mobile apps, and analytics (**Figure 2**).

The LMS uses an application programming interface (API) provided by the comments service to integrate disc. The Open edX provides a mobile application for iOS and Android and its analytics capture events describing learn behavior. The events are stored as JSON in S3,

	Max. class size	Brandable	Custom analytics	Monetization	Mobile	Hosting
edX	300,000	○	○	○	○	Self-hosted
Moodle	10,000	○	○	○	○	Self-hosted or 3rd party
COURSEsites	Unlimited	X	○	X	○	Hosted
Udemy	Unlimited	X	X	○	○	Hosted
Versal	Unlimited	X	X	X	○	Hosted

Source: Swope [27].

Table 3. Comparison of main MOOC platforms.

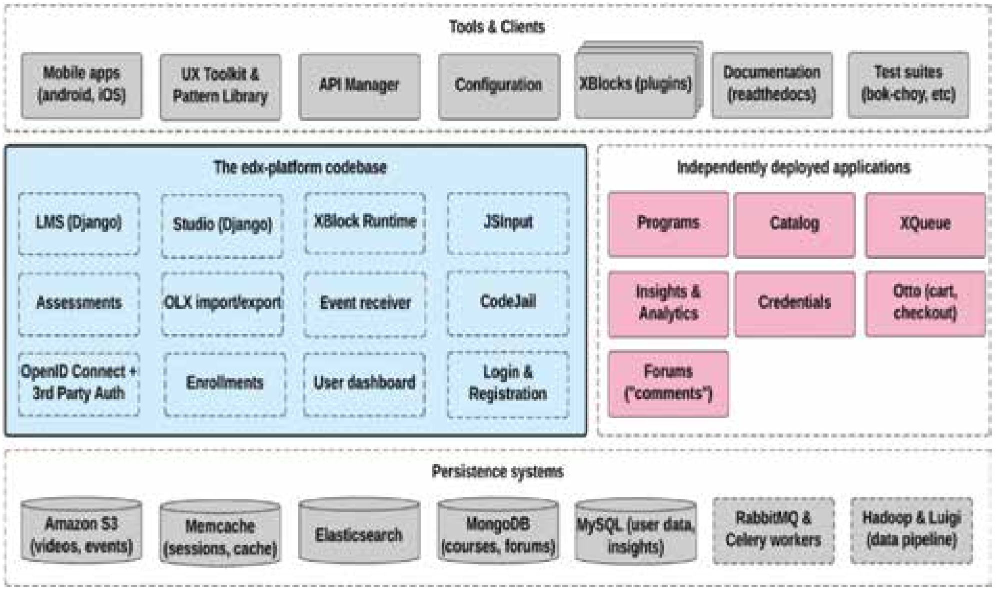

Figure 2. Open edX architecture. Source: https://edx.readthedocs.io/projects/edx-developer-guide/en/latest/architecture.html.

processed using Hadoop, and then digested, aggregated results are published to MySQL (**Figure 3**). The service is supported by a collection of other autonomous web services called IDAs (independently deployed applications). Almost all of the server-side code in the Open edX project is in Python, with Django as the web application framework.

Let us see another example, the Korea-MOOC (K-MOOC) service. In 2015, Korean government launched the massive open online courses with 10 top leading universities in Korea. K-MOOC also utilizes an open source (Open edX) for developing the MOOC platform. K-MOOC service is composed of opening lectures, course registration & personal identification, on & offline learning, evaluation, sharing learning outcomes & utilization process, and performance procedures [29]. The K-MOOC platform includes LMS, LCMS, authoring system, smart device support system, integrated search system, user management system, operation & management system, and learning outcome management system (**Figure 4**).

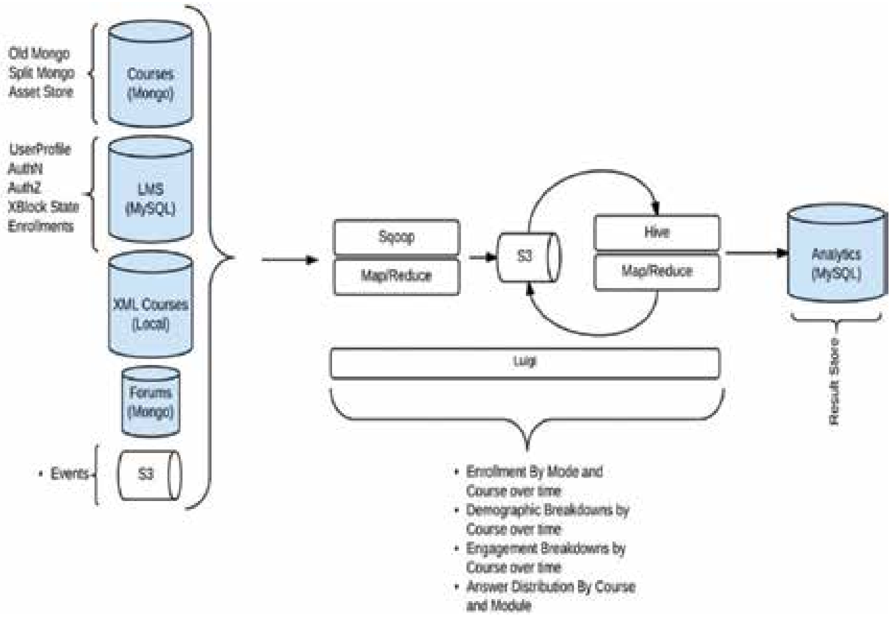

Figure 3. Open edX analytics pipeline architecture. Source: https://edx.readthedocs.io/projects/edx-developer-guide/en/latest/architecture.html.

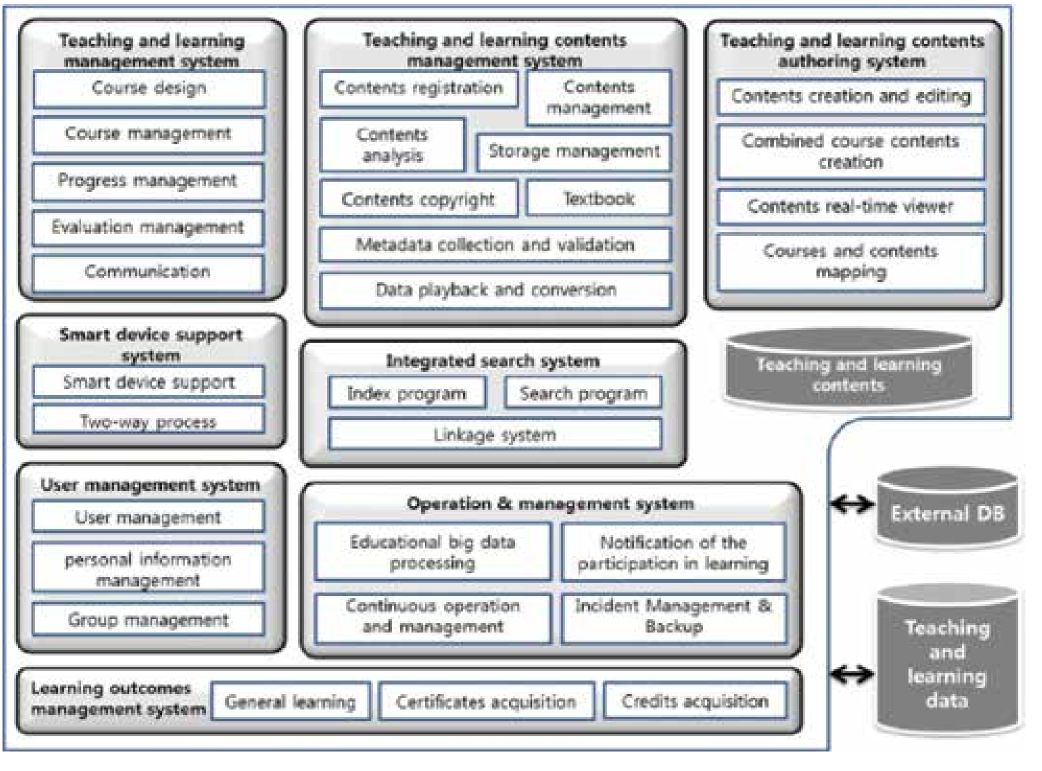

Figure 4. Configuration of K-MOOC. Source: Kim [29].

5. Development of a MOOC

Now let us think how to develop a MOOC. The first thing to do is choose what to teach. Existing online courses can be converted into a MOOC and new subject can be a MOOC. If there are existing video clips, time and cost can be saved. It is important to choose key MOOC activities (aggregation, remixing, repurposing, feeding forward) at the aspect of pedagogy [30]. The activity of "aggregation" (e.g., filtering, selecting, gathering personally meaningful information) will be performed through lecture notes, presentation slides, and case studies. "Remixing" (e.g., interpreting the aggregated information and bringing it to personal perspectives and insights) will be facilitated through online quizzes and assessments. "Repurposing" (e.g., refashioning the information to suit personal purposes) will be promoted through interactive assessments, mock-up apps, and peer & self-assessment. Assessment can be the most difficult activity to conduct online. Special attention should be devoted to proctoring and cheating. The "feeding forward" activity (e.g., sharing the newly fashioned information with and learning from other participants) will be performed through collaboration mechanism and features (i.e., discussion forum, twitter, blog, wiki).

Figure 5. Phase 1: Planning the course.

For an example of developing a MOOC, Udemy, which provides a MOOC platform for free, can be suggested for introducing how to create a MOOC. Udemy is an instructor-directed MOOC platform, not a university or private platform provider. The process consists of four steps: plan the course, create the relevant content, publish the completed course, and promote the course through various channels. At the first step of planning the course, an instructor visits and joins Udemy (**Figure 5**). He or she must be well acquainted with Udemy's guidelines for developing a MOOC. Second, the instructor must set the course's learning objective & audience and outline a curriculum (**Figure 6**). Also, prior considerations should be taken

Figure 6. Phase 2: Creating the relevant content.

about course duration, content structure, learning activities, globality of learners, etc. A good way to decide on the content or topics is as follows [31]:

Make a list of the possible topics that could be derived from the general and specific objectives.

Choose the essential topics that are directly related to the objectives.

Note the topics that appear at the top of the list once the essential items have been removed. Third, an instructor must create a test video and get feedback on his or her video production from our review team before recording your entire course (**Figure 7**). And the instructor uploads materials to lectures.

Figure 7. Phase 3: Publishing the course.

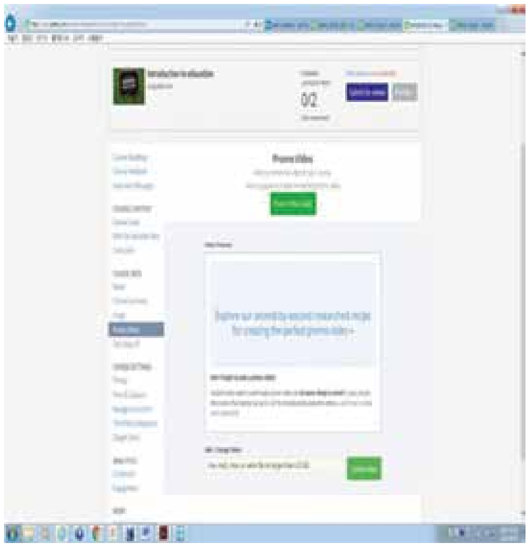

Figure 8. Phase 4: Promoting the course.

Fourth, promoting the course follows (**Figure 8**). An instructor should refine the course title and subtitle. He or she must make the course look professional with goals, objectives, a summary, and his/her instructor bio.

6. Future of MOOCs

MOOCs are state of art. But the high technology cannot ensure the quality and success of MOOCs. Does a MOOC-based program lead to a degree from an accredited institution? It may not be easy. Although MOOCs have the strength of free courses, free courses are far from a degree from an accredited university. Because learners must pay for the degrees. It explains that MOOCs are situated with being self-contradicting between access and cost. There is no such thing as a free lunch. Although there have been lots of other forms of open educational resources (OERs) or Open Coursewares (OCWs) in the world, nobody is sure whether this movement has been successful in improving the access opportunity toward higher education or not. It is near a myth that the MOOC-based program will not only democratize higher education but also end the unsustainable trajectory of tuition. The strongest disruptor is the selfishness of traditional higher education institutes. It just seems that MOOCs threaten so-called “brick-and-mortar” institutions. In fact, the traditional higher education institutes hold the initiative of the MOOC-based program. And learners also have been interested in MOOCs from traditional universities rather than only MOOC-based institutes, especially for a degree. The universities offering MOOCs were generally not willing to provide their own academic credit for the courses: citing residency requirements, they claimed to be protecting the integrity of the residential-campus experience [32]. Accordingly, MOOCs may remain be “tsunami” of a teacup.

MOOCs may bring not only affirmative sides including autonomy, diversity, openness, and connectedness/interactivity through online courses, but also negative aspects such as limitation of the learning potential caused by the lack of structure, support, and moderation normally associated with an online course [33]. High noncompletion rates are related to the issues of quality, sustainability, and pedagogy: “Although improving the quality of learner’s learning is one of the priorities of the major MOOC providers, most of their courses currently lack a sophisticated learning architecture that effectively adapts to the individuals needs of each learner [34].”

Based on the facts mentioned above, several recommendations can be suggested for the success of MOOCs. First, a combination of xMOOC and cMOOC is needed for pedagogical aspects as well as reuse, revision, remix, and redistribution of courses. As alternatives to MOOCs, hMOOC, MOOR, MOOL, DOOC, POOC, and SPOC can be suggested [21]. Second, instructional strategies should be transplanted into the course in order for learners to perform autonomous self-study and reflection upon interaction with other participants in an open social context [30]. Third, strategic communication system (e.g., regular messages) should be provided. It will assist to maintain the engagement and focus of learners on the course experience and to enhance the perception of “teaching presence” by learners [30]. Vardi [7] pointed out an "absence of serious pedagogy in MOOCs" and criticized the format of "short, unsophisticated video chunks, interleaved with online quizzes, and accompanied by social networking."

MOOCs have the potential to enable free university-level education on an enormous scale. A concern about MOOCs is also very big. Compared with the fast expansion of MOOCs through utilizing well-packaged course materials, instructional design quality in majority of MOOCs scored low [35]. Fischer [5] said, “whether or not a particular learning environment (e.g. a specific MOOC course or MOOC platform) succeeds depends greatly on whether students can learn what they want and when they want it, freed from the restrictions of curriculum consisting of desirable and undesirable content that has been segmented into majors and degree programs.” MOOCs can win success when they stick to the first great cause of free-paying university and make an effort to be pedagogically driven rather than technologically in teaching and learning design.

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Massive Open Online Courses (MOOC) and Its Possibilities as Instrument of Formal, Nonformal, Informal and Lifelong Learning

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65930

Abstract

In this chapter, we present the definition, development, and providers of massive open online courses (MOOC). We also explain the advantages and disadvantages of MOOC. We also present the structure of participants of MOOC, and also the motivation of participants is analyzed. Some basic statistics of realization and success of participants are also displayed. In one part of this chapter, the authors present case study of MOOC implementation in formal education in Belgrade Polytechnic (BP) College. For informal learning, a MOOC for welding is presented. This MOOC is planned to be organized on faculty of mechanical engineering at Belgrade University. During MOOC, participants also expanded their knowledge base and in that way they created possibilities for rerun of MOOC on a higher level. In that way, a participant can attend the same course after a couple of years and then will upgrade his knowledge. This attribute makes MOOC an instrument for lifelong learning.

Keywords: MOOC, education, formal education, nonformal education, learning

1. Introduction

In formal education, such as the development of technology and communication systems, there was no significant transformation in knowledge transfer. Development of technology in information and communication technologies (ICT) did not change the way of knowledge transfer. Lecturers still transfer their knowledge by tutoring students face to face. Significant improvements have been made in the implementation of ICT, but more in a way as educational tools. Even all E-learning systems are based on screen adaptation of lectures and web or mobile communication.

Such educational access enables significant improvement in speed and quantity of data exchange, but in educational approach nothing is changed especially in formal learning.

In the last 10 years, the environment (mankind) has become aware that it must be changed over, including the education system itself. Also other forms of education, formal and informal, become more important. There is also the need for lifelong learning (lifelong education).

2. Formal, nonformal and informal education

Education is a process of transferring knowledge from one generation to the next. Earlier, the knowledge passed down from generation to generation very often on an individual basis. Development of technology and society indicated the need for specialized knowledge, but it was no longer possible to organize as individual education in the more developed areas, such as school. First elementary schools were developed than secondary and finally higher education.

Education, in which the aim is to acquire knowledge and to certify for a system of schools that usually control the state apparatus, is called formal education.

Nonformal education also includes a conscious vision of education, but outside the formal education system. So it is adapted to the needs of the target group. Participants who attend this education are from different age groups, with different prior knowledge and different experiences. Learners are expected to be active participants in the education process.

Informal education is in fact the broadest form of education that people gain essentially based on the information in their environment. This process of education includes all the knowledge, skills, and logic that a single entity may acquire through daily communication with the environment, either with other people, media presentation, everyday experience in dealing, etc. This form of education is a good example of lifelong learning.

3. Systems of education

Education systems may be different over the conventional school system, through various specialized courses in different training system. All systems are designed to convey some knowledge from one person to another or among various persons.

Development of information and communication technologies significantly influences on the development of various models of knowledge transfer but is still dominated by the classical method of teaching. ICT has primarily enabled virtualization and adaptation of classes and found improved understanding of the participants through its application. Also, web development and communication systems have accelerated, modernized, and facilitated the transfer of information, but also drastically increased availability of information in the development of educational models [10].

http://dx.doi.org/10.5772/65930

One of the models of knowledge transfer and improving the education, primarily in nonformal systems of education, is massive open online courses (MOOC) phenomenon.

The occurrence of MOOC (massive open online courses—massive courses on the net with an open access) may indicate the future direction of the education system.

Many thought that MOOC courses will overcome all other learning systems. But is it so?

4. MOOC

Massive open online courses (MOOC) belong to the section of distance learning (DL). They evolved from the classic DL environment under the influence of the movement for free using learning resources (open educational resources movement – OER). Moreover, MOOC in an organization is the basic element of knowledge transfer and communication, and it is transferred by using a DL-platform like Moodle, Blackboard, Iversity, Edmodo, etc [4, 13].

MOOC's basic idea is that an online course does not have a limited number of participants and has full free and unlimited participation via the web. MOOC means that in addition to the completely free use of all the traditional forms of teaching the course, other methods are also used, such as interactive blogs, sites, and all forms of communication via the web and mobile telephony. The purpose of this platform is in fact to work with the masses, and the transfer and dissemination of knowledge to large groups of people who want to gain knowledge in a certain field. It also ensures that all informal knowledge dealing with a particular topic is provided along with the development of formal knowledge. This approach is based on the fact that some kind of "peer to peer" network communication is held, except where the moderators' (trainers') course can communicate with each other and thus transmit knowledge and information about a particular area.

Figure 1. MOOC definition.

Historically, the first MOOC was activated in 2008 by G. Siemens and S. Downes and named it "connectivism and Connective Knowledge"—better known under the name CCK08 [5]. The two trainers held classes for 25 students in Manitoba University and opened an online course, which was attended by 2200 participants. The theme of the course, which from its name can be concluded, was to connect people and their general and specialized knowledge through their collaboration on the web. The exchange of information took place via blogs and through organized discussions on Moodle and Second Life platform. The very flow of information on the web could be traced via RSS (Rich Site Summary) queries.

After the appearance of the first MOOCs, rapid development of courses followed that had common characteristic in the beginning and were free, which caused a lot of interest in this kind of platform of DL (**Figure 1**).

5. cMOOC

Nonprofit MOOCs, based on the free exchange of knowledge and active participation of all stakeholders in the development of knowledge in certain areas, are also known as cMOOC (where c before the word refers to the term MOOC connectivism or merger or cooperation). Their main characteristics are that the exchange rate can be initiated by any person, and there is no one moderator or speaker but all active participants in the exchange of information in certain areas and thus increase and deepen their knowledge [9, 11]. It should be noted that there are an unlimited number of players in the MOOC (when in each course the number of participants was greater than 100,000) and also all forms of literature and materials in the course are free to use. It can be concluded that due to the availability of material on the web and the huge number of very complex information to filter all the data, a large number of participants take advantage of such a platform. Also, here you can come to the conclusion that the group of MOOC participants in a single moment can focus their interests to some other field and "give birth" to another MOOC and MOOC is a topic that builds on this knowledge. Also, because of the free mutual communication of students within, the MOOC recognizes users with the same interests, similar problems, and even after that the MOOC continues to communicate with each other and thus continues to work on the development of knowledge in a MOOC and can start a new MOOC [2, 9].

6. xMOOC

Since 2012, the first MOOC course that was not free appeared. In now days we can see that the providers of courses are universities and prestigious companies instead of nonprofit groups and individuals. The characteristics of these MOOCs are different from classical cMOOC platform. First of all, these MOOCs are based on the classic platforms and methods of knowledge transfer in DL. Usually there is one or a group of moderators. Managers and trainers in this case have far greater control over the realization of MOOC and execution of tasks within it. Participants have a relatively small part in the creation of materials for the further development of knowledge. The number of students is unlimited, but the access to the material of the course is limited to only those who have registered as participants. If the student wants a certificate of completion of the course, he must pay for it and it is often not a small sum. This MOOC is also called xMOOC. A large number of prestigious universities have developed this platform for their courses [3, 12, 16, 18]. Partly this was done due to the expansion of knowledge and partly to create interest in potential students for these universities. Also in this case, a MOOC meet and communication with people from different backgrounds and with different interpretations of the problem may lead to the transfer and development of knowledge in a wide variety of environment.

This course does not belong to the formal aspect of education, regardless of what they have been usually created for by different educational institutions or firms with access to specialized training, and as such can be classified as a nonformal form of education. Even if the majority of students do not qualify for a certificate, participant's level of knowledge definitely grows at the end of completing the course.

The positive direction of development of such informal courses, first of all, is to inform and educate people in the ways of exercising their rights. Also, some of the countries aim in this way to improve the qualification of the working population, for example, in India, where there are a large number of people who are computer illiterate. In India, the courses are organized by the state and sponsored by strong companies in order to improve this condition [17].

7. Expansion of MOOC and providers of this platform

The year 2012 can be regarded as the most significant for the development of MOOC platforms. During this year, a group of powerful financiers, in cooperation with known universities, has placed several well-known platforms for MOOC: before all, that refers to a platform *Coursera* by qualified institutions such as the University of Maryland, Wharton School, University of Virginia, Stanford University, University of Houston System, University of Tokyo, and University of Edinburgh [18], and then to the platform *Udacity*, which has been created by Georgia Institute of Technology, San Jose State University, Google, Salesforce.com, Facebook, Cloudera, NVidia, Autodesk, and Cadence, and *edX* platform backed by MIT, Harvard University, UC Berkeley, Kyoto University, Australian National University, University of Queensland, IIT Bombay, Dartmouth College, and Universidad Autonoma de Madrid [16]. These three platforms are the best known and most developed, because large financial institutions are financing them. These platforms organize a large number of courses in different fields. Let us just say that Coursera MOOC organizes more than 1000 courses in cooperation with about 120 partners.

MOOCs organized by these platforms are attended by more than 14 million participants.

Even though these platforms are financed by major financiers, it should be noted that the platform edX is not profitable and it has maintained the principle of free access to all the materials and all the participants.

Provider	Course type	Organizations	Country	Year of establishment
XuetangX	Nonprofitable	Tsinghua University	China	2014
WizIQ	Commercial	IIT Delhi, Des Moines Area Community College	India/USA	2007
Université Numérique France Université Numérique	Nonprofitable	Institut Mines-Télécom, Conservatoire National des Arts et Métiers, École normale supérieure de Cachan, University of Paris-Sud	France	2013
Udemy	Commercial	Professors from Universidad de Chile, University of Chicago Law School, George Washington University, and other institutions.	USA	2010
Udacity	Commercial	Georgia Institute of Technology, San Jose State University, Google, Salesforce.com, Facebook, Cloudera, Nvidia, Autodesk, Cadence	USA	2012
Stanford Online	Nonprofitable	Stanford University	USA	2006
Peer to Peer University	Nonprofitable	nije navedeno	USA	2009
OpenLearning	Commercial	University of New South Wales, Taylor's University, University of Canberra	Australia	2012
openHPI		launched in September 2012 by the Hasso Plattner Institute at the University of Potsdam, Germany	Germany	2012
Open2Study	Commercial	James Cook University, Griffith University, University of Wollongong, Flinders University, RMIT University, Central Institute of Technology, Sydney Institute, University of Western Sydney, Polytechnic West, Macquarie Graduate School of Management, Swinburne University of Technology, University of Newcastle, Jordan University of Science and Technology, University of Tasmania, International College of Management, Sydney, e3Learning, Enterprise Architects, Massey University, Macquarie University, Gowrie Victoria, South China University of Technology, TAFE SA, Curtin University	Australia``	2013
One month	Commercial	School of Visual Arts	USA	2013
NPTEL	Nonprofitable	Indian Institutes of Technology, Indian Institute of Science	India	2006
NovoEd	Commercial	Stanford University, Wharton, Princeton, Darden, Comcast, Carnegie Foundation, Universidad Católica de Chile	USA	2013
MOOEC	Nonprofitable	University of Queensland, Griffith University, Queensland University of Technology	Australia	2013

http://dx.doi.org/10.5772/65930

Provider	Course type	Organizations	Country	Year of establishment
Master University	Commercial	Launched in January 2015 by the Miramondo Network s.r.l.	Italy	2015
Khan Academy	Nonprofitable	nije navedeno	USA	2006
University	Commercial	Universidad Autonoma de Madrid, University of Florence, University of Hamburg	EU	2013
FutureLearn	Commercial	University of Birmingham, University of Edinburgh, University of Reading, Open University, Monash University, Trinity College Dublin, Warwick University, University of Bath, University of Southampton	UK	2012
Eliademy based on the Open Source MoodleVirtual learning environment.	Commercial	Aalto University Executive Education The site is localized to more than 19 languages (including Latin), designed for mobile use.	Finland	2012
edX	Nonprofitable	MIT, Harvard University, UC Berkeley, Kyoto University, Australian National University, University of Queensland, IIT Bombay, IIM Bangalore, Dartmouth College, Universidad Autonoma de Madrid	USA	2012
Coursera	Commercial	University of Maryland, Wharton School, University of Virginia, Stanford University, University of Houston System, University of Tokyo, University of Edinburgh	USA	2012
Canvas Network	Commercial	Santa Clara University, University of Utah, Université Lille 1	USA	2008
Academic Earth	Nonprofitable	UC Berkeley, UCLA, University of Michigan, Oxford University	USA	2009

Table 1. MOOC providers.

One of the most famous nonprofit financial donors to these organizations is Bill Gates.

There are other MOOC platforms, but they do not have such a large number of courses and participants [15]. Although, there are platforms developed in local conditions aimed at increasing competence and general literacy of their population.

The principle of freedom of access to MOOC in each case leads to a multinational and multicultural development of communication and knowledge transfer, so that this kind of platform has a benefit to all participants, and perhaps especially to those whose communities' topics related by MOOCs are not developed enough. Fact is also that the individual courses are listened by thousands of listeners from dozens of countries.

Data show that about 45% of the participants follow the courses in nonmaternal language, which supports the claim on the internationalization of this type of education.

Monitored data show that about 45% of the participants follow the courses in non-maternal language, which supports the claim on the internationalization of this type of education [14].

Depending on the wishes and needs, each student can easily find a platform and MOOC that he can attend.

Table 1 presents the providers of courses and institutions that participate in them, including profitability rate and the year when the provider was established.

8. MOOC participants

Who are in fact the participants of such courses, what is their motivation, how do they attend a course, how many of them give up, and how many of them complete a course? These are the key questions that have to be answered; also is the MOOC platform the future of the education or is it just one of the experiments, transient phase in the creation of future platforms for DL?

To be a participant of this course someone, first of all, must be computer literate at some level. Because except work on the computer, participant must be fully aware of the Internet, as well as some of the IT tools which are used during the MOOC, primarily in communication.

This means that participants of such courses are usually high school students and graduates. Also, if it is a specialized theme, a large number of participants may be masters and doctoral students, as well as PhDs in certain fields.

In addition to computer literacy, there is a need for knowledge of the languages of the developed world, as MOOC by definition does not develop as a local platform. Organizers usually choose the most common language and it is usually English. Normally, if it is a locally developed MOOC platform it is organized using the local language.

9. The motivation for attending these courses is different

As can be seen from **Figure 2**, a good portion of students are choosing the course where they expect the exchange rate to be more interesting than courses that they have already seen.

Second, course participants elected the reasons to improve their knowledge in the current and previous education. Their desire is to upgrade their skills. They are based on the level at which the course is held and depending on the information obtained they do not have a priority to complete the course [3, 8].

Part of the participants considered that the MOOC will create benefit in their professional work. These students have the imperative of completing the course and acquiring certificates for better positioning in the professional environment.

A number of users choose the course according to the organizers; they expect to learn more from lecturers from prestigious institutions in the field of education [14].

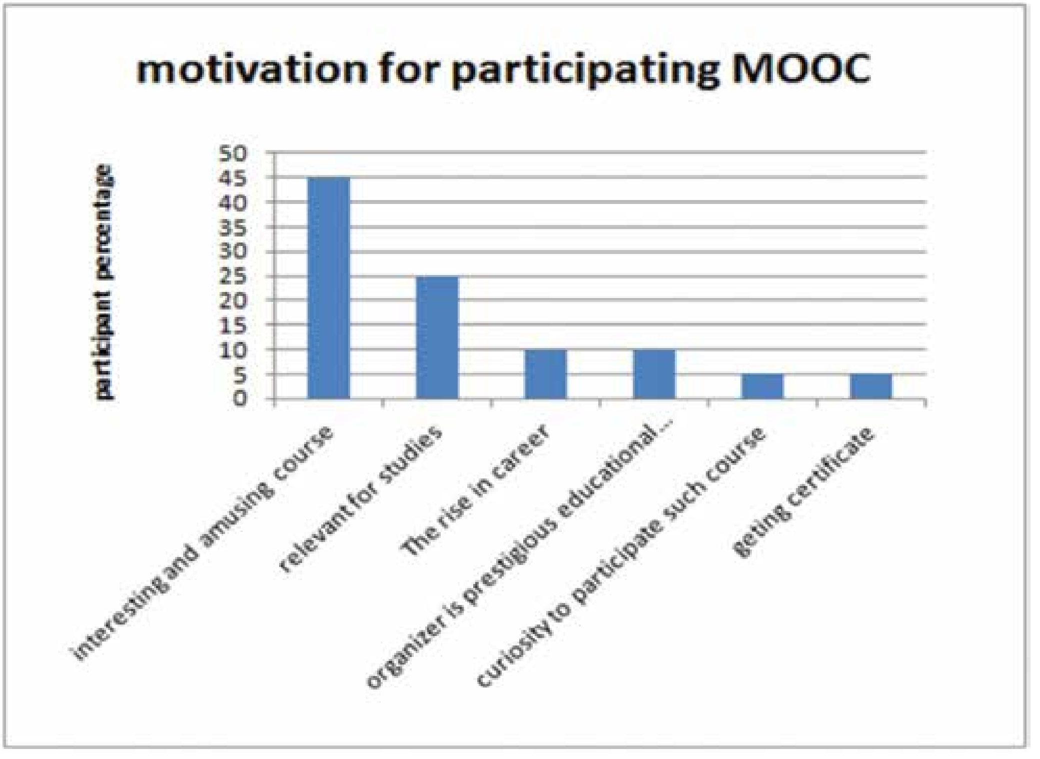

Figure 2. Motivation for participating MOOC.

While some of the participants got enrolled out of curiosity, they implicate that they want to gain as much information as possible from the course. These attendants are usually people who normally browse the web and often do not finish the course. In some moment, they satisfy their needs for specific information and after that they leave the course.

In fact, there is not an accurate cross-section of states when a certain part of the student stops to listen and attend a course. This is reflected primarily in the fact that a score of 6–10% of participants who have completed a course is considered very good, even excellent results.

Attention must be on the fact that so far the largest number of participants in these courses is from America (49%), followed by Europe (31%), then in South America, Asia, and Africa (**Figure 3**).

This data indicates that people from developed areas often choose additional education primarily to better their basic education, and develop their knowledge of technology. In this case, MOOC is an excellent tool for nonformal and informal education, primarily because it is free.

As far as gender is concerned, more females participate in these courses than males.

Most participants of MOOCs had previous experience with DL systems. This indicates that DL systems have a positive impact on the development of the desire for further education through the web.

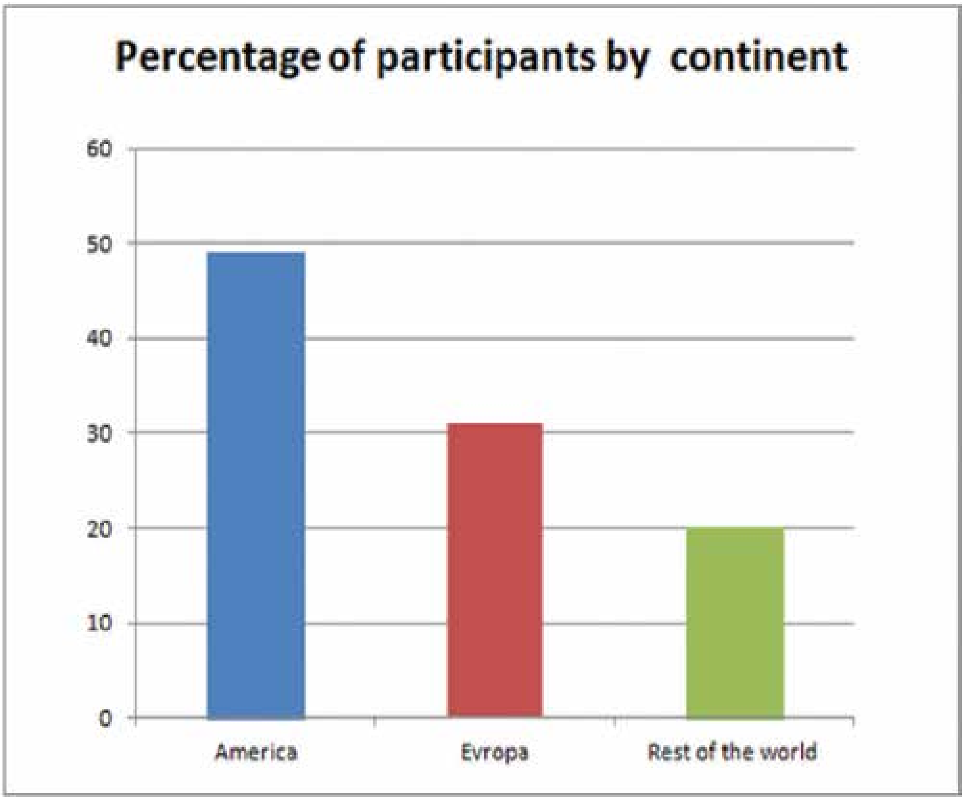

Figure 3. Percentage of participants by continent.

10. Why MOOC has an important role in education?

First of all, it is because a large number of participants in MOOC acquire at least basic information about their topic of interest from these courses. Also, students who have previous experience in these fields meet their needs for additional information. Participants do not need to have any kind of certificate or diploma of previously acquired knowledge [2, 3].

However, the biggest shift is that the students are the future students to the DL systems, and get used to the way of working of their future colleges and universities.

The large number of participants, for whom these are not core areas, acquires knowledge that does not have to be certified. They get knowledge that can further increase their level of skills and functionality of the primary areas. In essence, this mix of different skills in various fields is the basic contribution to the development of general knowledge.

One of the advantages of MOOC is that it can be organized by anyone who wishes to exchange and upgrade knowledge in specific areas. The important thing is how fast organizer can gather students and inform them when the course begins [4].

It is also important that MOOC can be arranged regardless of the time zone and physical limitations. There are no limits with the MOOC. You can and it is desirable to use all the social networking and communication tools that are the most developed in the region where you target the largest number of participants [6].

Contextual content can be shared by all participants of the course.

It is good that knowledge is gained in a less formal setting, so that all the participants can be much less limited in the communication.

Coincidentally, participants can reach new findings thanks to the exchange of unknown information in order to solve given problems.

It is equally important that in this way a participant of MOOC increases his skills in lifelong learning and increase his opportunities for greater absorption of knowledge.

One of the biggest advantages of MOOC is that its activities do not have to stop after the completion of the course. Since the MOOC is based essentially on the "peer to peer" network, a number of participants continue to be in a relationship and create its own network for the exchange of knowledge in the field where MOOC was organized.

11. MOOC organization

As we have repeatedly said, MOOC can be organized by any individual or group of people in order to share and develop their knowledge of the environment [4, 6, 7].

However, we should be very careful with the choice, first of all, course topics. It is possible that the course, especially cMOOC went in another direction, because the original theme loses significance.

Very important, if not crucial, thing in defining and organizing the course is the choice of tools—software applications, which will be used by the course participants. Organizer should aspire to, as a base platform for the exchange of data, use the most commonly used applications in an environment where the course is held. It is also preferred that the course is supported by multiple communications platforms. We think that the course should not be maintained only through the web, but also through mobile network, such as android or any other supported operating system and software.

If possible, we can use as a platform DL systems that are used in our environment.

12. MOOC and VSSS Belgrade Polytechnic

VSSS Belgrade Polytechnic (BP) has been trying in recent years to establish and accredit DL system. In one part, it was very successful, but it also had significant problems in implementation.

The first attempt of implementing DL was the use of the Moodle platform. Several subject teachers dared to put their teaching duties through this platform and to monitor the results of implementation. At the beginning, students showed interest in this form of learning and achieved results very similar to those that have received classical education. However, the absence of "moderators" and the real practice presented a problem with this form of education. The platform has proved to be an excellent means for information exchange, lectures, conducting quizzes, and record the assumed material and activity of students.

To further develop the technology and software, as well as monitor information from the environment (informal education), we came up with the idea to create a platform for teaching in the form of a MOOC.

It is designed in the following approach:

- Communication takes place via e-mails and hangouts application on Google service. BP uses Google Education system for some time.
- Exchange of written and video materials is carried out through Google Drive. Also, for the organization of teaching and exchange of materials, Google Classroom is used.
- Video tutorials and online consultations are done via software BigBlueButton. Lectures are performed repeatedly in small groups and can be downloaded and saved via Google Drive.
- For testing we use MOODLE or QuizFaber software.

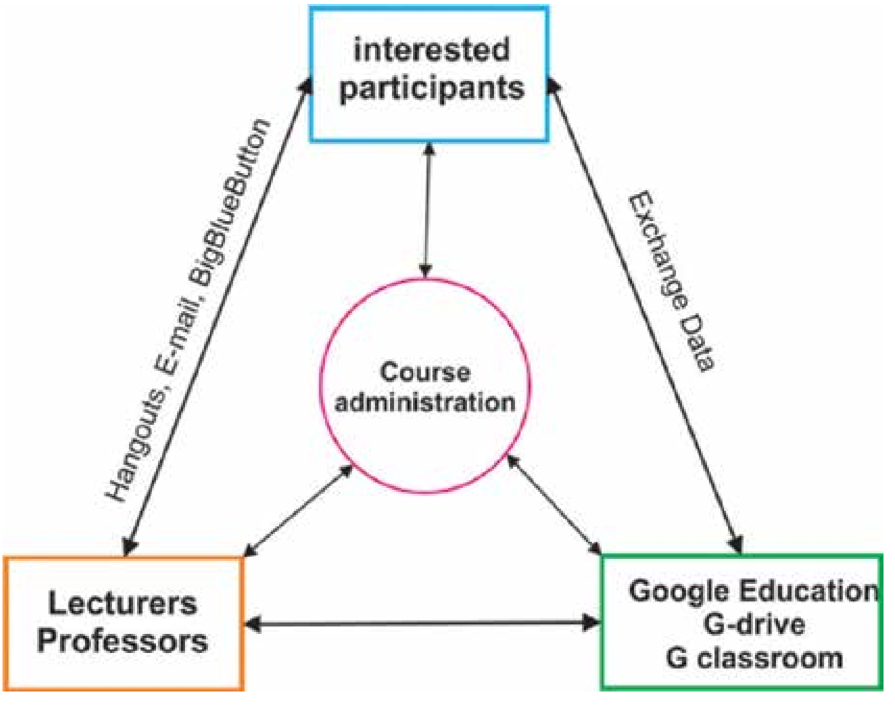

Figure 4. Basic scheme of communication on course.

All students have the opportunity to sign up to follow the course subject. In the future BP will also enable that all interested parties outside BP can follow the course if they want to. All materials are and will be available to students, and they can exchange opinions on students' blog. If they have uncertainties they can schedule an online consultation with the lecturer or assistant.

The basic scheme of communication is illustrated in **Figure 4**.

Problems that occur are primarily of technical and financial nature. Better applications are relatively expensive and the biggest problem is the upload of video streaming, because the speed of the ADSL connection is relatively small and often vary, so there is plenty of downtime. Because of this, the groups are often very small, only five students, which is not adequate for the number of people interested in the lessons of course.

13. MOOC and Faculty of Mechanical Engineering, University of Belgrade

Faculty of Mechanical Engineering, University of Belgrade, accredited the course for International Welding Engineers (IWE) according to the program and rules of the International Institute of Welding (IIW) and according to the document IIW Guideline IAB-252r3-16 [1]. A candidate completing the IWE training under this program is expected to acquire advanced knowledge and critical understanding of welding technology application, which demonstrate the following: technology mastery and required innovation, being able to solve high-level complex and unpredictable problems, the ability to manage high-level complex technical and professional activities or projects related to welding applications, and taking responsibility for decision making in unpredictable work or study context [19].

The course consists of 448 hours, of which 388 hours refers to theoretical training and 60 hours is intended for practical training. The modular course content is given in **Table 2**, in the following structure.

Total number of hours is divided into three parts: Part 1, Part 2, and Part 3. Part 1 includes main topics and basis of "welding processes and equipment" (46 hours), "materials and weld ability" (33 hours), and the computation of forces and tensions and the presentation of weld (14 hours). Fundamental knowledge of those sections is the basis for the attendance of Parts 2 and 3 of the course. Part 2 is practice and laboratory, while Part 3 refers to welding processes, behavior of metals subjected to welding, design of welded joints, fabrication, and applied engineering.

Participants must have a primary degree in an engineering discipline or its equivalent recognized by the national government and assessed by the ANB. Therefore, it is expected that participants have at least a Bachelor degree at university level with a minimum study of 3 years.

The Standard Route of this course is given in **Figure 5**, and this is the route recommended by IAB (International Authorization Board) as offering the fastest, most comprehensive manner in which the syllabus may be covered. The Standard Route also allows a limited amount of

Modules of theoretical education and fundamental practical skills	Number of hours
1. Welding processes and equipment	95
2. Materials and their behavior during welding	115
3. Construction and design	62
4. Fabrication, applications engineering	116
Sub-total	**388**
Fundamental practical skills	**60**
Total	**448**

Table 2. Structure of IWE course content.

prior learning (Part 1 of each qualification course) to be taken into account, for example during university or college courses.

The course is very demanding, expensive, and time-consuming. Bearing in mind that the majority of participants are employed full-time, one of the main problems, in addition to the price, is absenteeism.

Since 2001, there is possibility to take the Part 1 of the IWE as a distance learning course. Students have the chance to choose their individual time to learn. For companies, the use of a training program for the evenings or at the weekend means less loss of working hours and saves cost. Further, there are no travel expenses, cost for journeys, or stays overnight as well as other expenses. An important advantage is that in case the participants already have certain knowledge concerning the single lesson they may be learned in shorter time or even can be skipped.

Bearing all this in mind, we came up with the idea to create a MOOC platform for attending the Part 1 of the IWE, which would be free. Namely, the IIW rules allow the so-called alternative route of the course. According to that route, students have direct access to Part 2 and that is primarily intended for those students who during their formal education at masters studies passed the corresponding exams.

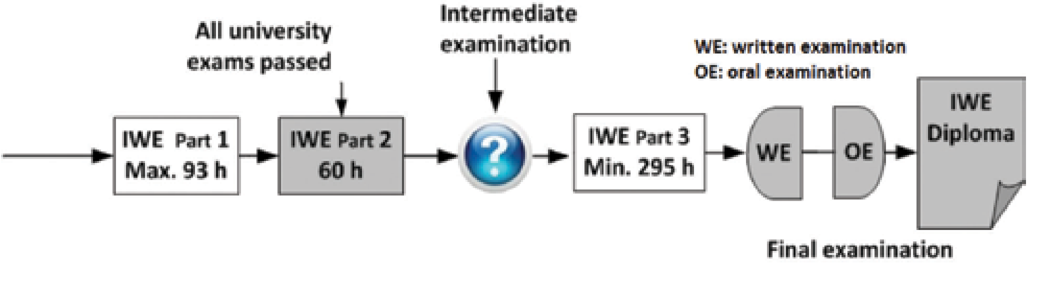

Figure 5. Standard route for IWE [1].

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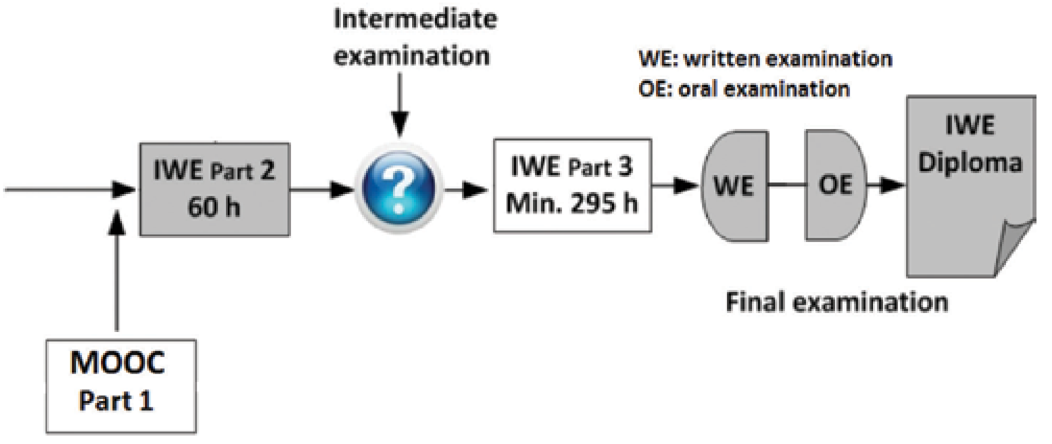

Figure 6. Alternative route with MOOC for Part 1.

In Serbia welding subjects exit only at the Faculty of Mechanical Engineering in Belgrade, this option is limited to a very small number of participants. Furthermore, it was observed that students from other faculties have difficulties in certain areas of the course, mostly covered with Part 1, because they do not have enough background knowledge, and additional mentoring is necessary. We believe that MOOC platform would be ideal for such work. Schematic representation of an alternative route for IWE course with implemented MOOC platform is shown in **Figure 6**. Students who have successfully passed the intermediate examination (Part 1) of the course are allowed to attend Part 2 and Part 3 of the course.

The main advantages of MOOC course for Part 1 are:

- Shortening the duration of a standard course.
- More participants for attending standard course.
- Raising the level of prior knowledge of participants.
- Individual tutorials with the students.
- Massification of the course.

The program can even be used without specific PC knowledge. It does not take long preceding times to become familiar with the subject. Hardware/software system requirements are:

- Windows NT/95/98/2000/ME/XP/Vista/Windows 7.
- Screen resolution 1024× 768 pixel.
- 10 bit depth of color.
- CD-ROM Drive.

Part 1 consists of 93 teaching hours, divided into 23 lessons. For each lesson is given a number of hours, which indicates the depth to which a topic is dealt with. This will be reflected in the scope and depth of the examination. Each lesson is supported by text, sound, images, video films, and interactive animations. By using the media mentioned the contents are given close to practice with the effect that the motivation to learn remains high.

Participants will receive a detailed schedule of lectures with dates. Since continuously learning is very important in this type of course, due to the large volume of material, it is planned that the lessons will not be placed all at once, but according to a specified schedule.

Lectures for a total of 24 teaching hours will be posted on Monday and the candidates will be able to download them. On Friday, candidates get homework and knowledge test and have deadline until Sunday to do and return it. Online consultation via Skype will be on Wednesdays, Thursdays, and Saturdays from 18 to 20 hours, since it is assumed that the majority of participants are employed. On next Monday, the previous lessons are removed from the site and the following are uploaded. If a candidate did not do his homework, he will not have access to new lessons and thus there is no possibility of further follow-up classes. Thus, it is envisaged that, within 4 weeks, all the lessons planned by the program will be realized. After the completion of the last homework, in the fifth week, the online exercise is planned, candidates get a general catalog of questions to help them to prepare for the examination with daily consultations.

We believe that, after all, the candidates will be ready for the intermediate examination, which will be held at the Faculty of Mechanical Engineering, and that also will be for free, since it is a condition for the main course. After passing the exam, candidates are included in the standard route of the course, or to follow Part 2 and Part 3. According to the rules of the guideline, the complete IWE/IWT course has to be finished within 3 years.

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Digital Factory and Virtual Reality: Teaching Virtual Reality Principles with Game Engines

Petr Hořejší , Jiří Polcar and Lucie Rohlíková

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65218

Abstract

Virtual reality (VR) is widely used in various industrial applications. All leading industrial manufacturing companies today have a strategy called the 'concept of a digital factory' where all aspects of manufacturing are digitally verified on digital mock-ups prior to physical manufacturing. Other than that, it is a rapidly developing new medium and further development of VR and IT will open up new possibilities. The new concept of Industry 4.0 is based on using approaches like the Internet of Things, Cloud Computing, Cyber-Physical Systems and Virtual Reality. With the decreasing cost of VR devices, even smaller businesses are able to implement such technologies. It is therefore crucial that mechanical engineering graduates are familiar with these new technologies and trends. We had to use unconventional methods to educate mechanical engineering students in the latest trends in IT and VR. Back in 2010, there were almost no tools available for teaching how to create industry-themed VR environments, which did not require complicated coding, so we decided to make our own. To simplify the development, we used Source Engine as the core and enhanced it with a library of textures, models and scripts we called DigiTov. Although Source Engine is a game engine, the master logic of VR development is the same as for professional SW products. In autumn 2015, a group of 10 students modified the DigiTov for Unity3D, forming a team made up of different roles.

Keywords: Digital Factory, Source Engine, virtual reality, virtual reality education

1. Introduction

Leading industrial companies rely on virtual reality (VR) for the development of new products, which includes production planning, distribution, user experience and many other fields.

Virtual reality started to appear in the late 1980s, but it took about 30 years before it became available. Affordable devices like Oculus Rift, VR cases for mobile phones and augmented reality (AR) glasses have started to emerge in the last few years, creating the potential for use by small and medium businesses and home users.

Until recently, the prices of VR solutions had meant that they were only affordable for the automotive, shipbuilding and aviation industries and other big companies with very large production runs, or with smaller quantities of large and expensive products. For example, a decade ago, a Cave Automatic Virtual Environment (CAVE) device would have cost hundreds of thousands, if not millions, of euros. Today, consumer VR devices are available for thousands of euros at most.

Industrial uses of virtual reality are mainly in the automotive, aeronautical and shipbuilding industries. Many such industrial corporations have adapted their own concept of the Digital Factory (DF) [1]. Digital Factory, or 'Digitale Fabrik', is a German solution for shortening the product life cycle by taking advantage of data compatibility and real-time accessibility, simulation and visualization in virtual reality. Basically, a virtual counterpart of an actual production plant is used to virtually validate the production. This process eliminates errors and various problems without letting them occur in reality, lowering the costs and time demands and increasing the overall efficiency of the plant. The DF concept emerged in 2008 and has mainly been implemented by two leading companies: Siemens with their Tecnomatix software suite and the rival Dassault Systémes Delmia software.

As seen in the Czech Republic, the next step from DF is the Industry 4.0 (I4) strategy. It was proposed in 2013 [2] by the German government, and thanks to the Czech Republic's close industrial ties with Germany, it is in the process of adaptation by the Czech Ministry of Industry and Trade under the Czech name 'Průmysl 4.0'. This strategy consists of smart factories with autonomous scheduling, material manipulation, simulation and the introduction of the Internet of Things paradigm into production. For further details, see [2]. In this concept, a virtual model of the production plant is also necessary. VR is defined as one of the cornerstones of this 'fourth industrial revolution'.

Other than these two major concepts, virtual reality also has its place in production. CAD models not only compute the durability for a particular load, they can also be viewed or validated in head-mounted displays (HMDs) or in CAVE devices in order to support decision-making, and for validation of the design and appearance of a product. In combination with a digital human model or an actual person, the product can be validated by VR-powered ergonomics analysis. This means we are able to check, for example, whether a driver will have a good view from the driving seat, whether a certain grip is comfortable, or whether workers can reach all the necessary surfaces during an assembly operation without the risk of injuring their backs through unsuitable movements. Subsequently, the whole production system is fine-tuned using a simulation model to optimize its throughput and minimize the production costs. Basically, the whole product life cycle today is supported by virtual reality.

According to Gartner and his Hype Cycle for Emerging Technologies for July 2015 [3], VR and AR technologies are entering the 'Slope of Enlightenment' part of the hype cycle, meaning that

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usable solutions are slowly coming onto the market. Gartner estimates that it will take 5–10 years for such devices to create a new billion dollar market as Deloitte predicts [4].

This means the time is ripe for universities to consider education aimed at exploiting the advantages of VR devices and teaching the principles of virtual reality. Virtual reality is likely to become a new mass medium, potentially reaching numbers of users similar to those of other media such as TV or the internet. Students will need to understand the principles of using and creating VR. At the Faculty of Mechanical Engineering at the University of West Bohemia, we have been working with a CAVE-like device and other VR devices since 2009. Various projects and experiments have been carried out since then to make these devices accessible for students.

In 2009, there were very few possibilities for using virtual reality tools in an industrial environment. At that time, nobody knew how industrial virtual reality would evolve. We created a whole new subject which we called 'Digital Factory and Virtual Reality' (DFVR), which was designed to introduce virtual reality to fifth grade students at our faculty, and we needed a suitable tool for creating VR content for them in order to provide a practical experience. Industrial solutions were great, but too expensive, even with academic licences, and/or they were very hard to work with. We wanted an easy-to-use tool allowing students to focus on the content they would be creating.

Because of the lack of such a tool, we decided to design our own using a regular game engine. We created the DigiTov, a Source Engine–based library of assets and resources including 3D models of machines, workers, sounds, control logic, etc., so the engine could be used as a basis for creating industrial plant themed serious games. It was made available to students, and they enjoyed constructing their own virtual worlds in a very easy and understandable way.

Following the success of the DFVR subject, we decided to organize an annual workshop on virtual reality for secondary school students. We called it the Summer School of Virtual Reality (SSVR), which takes place at the beginning of July. Basically, it is a short version of the DFVR subject and more practically focused. As the Gartner Hype Cycle predicted, we have noticed an overall increase in the number of participants over the years, and participants have enjoyed the SSVR very much, claiming it was very interesting and useful.

Since 2009, there have been many changes and updates to these subjects. In this chapter, we would like to share the experiences and lessons learned from the DFVR and SSVR from a teacher's perspective.

2. State of the art

There are many examples of virtual reality being used in industry. Existing solutions range from simple passive visualizations to complex interactive and collaborative solutions taking advantage of multiple instances of VR environments. There are many reasons for students at engineering schools to learn the principles of virtual reality.

Today, virtual reality is considered to be an immersive, computer-generated environment that lets its users interact with it, influence it and feel its feedback. This concept is very old, but it has only become available in the last few years, mainly due to the high demand on the processing power of CPUs and GPUs. For example, the requirements for Oculus Rift or HTC Vive head-mounted displays (HMDs) are today's high-end gaming desktop computers. The processing power required for VR is high because of the stereoscopic 3D rendering in real time with a recommended minimum frame rate of 75 fps (frames per second). Another part of a VR system requiring high processing power is positional tracking, which requires the immediate transfer of the position of VR system elements to the computer. For example, when using a HMD, it is necessary to track its position in order for the computer to render the scene in the direction from the origin. All this must be processed at the desired 75 fps frame rate, leaving only 0.013 s to render one frame.

Figure 1. Augmented reality projection table. Touchscreen with black and white 'markers' is shot by a webcam. The marker-based 3D environment is generated and sent to a projector (original solution by Department of Industrial Engineering and Management, University of West Bohemia).

Other tracking issues arise with mixed reality (MR) systems. MR is a combination of a real and a virtual environment. For further information, see the details of the reality-virtuality continuum [5]. Augmented reality (AR) as a part of this continuum is basically the projection of 3D objects on to the user's field of view. The augmented scene is rendered on a screen, tablet, smartphone or a see-through HMD. This requires precision tracking in order to render the 3D objects in the correct position, rotation and size. Usually, this is provided by computer vision

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algorithms that recognize the context of the scene or find positional markers. An example of an augmented reality system with marker-based tracking is shown in **Figure 1**.

As early as 2007, production system design and validation were carried out in an augmented reality environment. Back then, the objective was to check whether a product would collide with elements of the production system such as robotic manipulators, whether it would fit into the clamps flawlessly, or whether parts would be aligned properly before welding [6]. At that time, the limited power of portable computers did not allow visualization of such scenes in real time, on site at an actual production system. Therefore, the scene was photographed using a high-end camera and processed at a workstation, and the production system was then evaluated and validated.

Today, augmented reality has reached a much higher level. As for production line maintenance, an interesting study with a now discontinued version of the Google Glass HMD is described in [7]. A user wearing Google Glass is guided through the maintenance process of calibrating a driver assistance system testing bay. The results showed that using this AR system, the maintenance worker could calibrate it much more quickly.

As for AR systems depending on image recognition and marker tracking, it is possible to quickly evaluate a production layout design. Similar to **Figure 1**, the markers can be printed on paper cards and 3D models are laid over them, as described in [8]. It must be said that although this is a very fast, efficient and understandable method employable by everyone, such a simple system is better suited to creating a first concept than for a full evaluation of a production line. Another advantage lies in the fast preparation and creation of such a system.

A more advanced wearable AR system was presented in 2014 in [9], consisting of active video tracking via a webcam rigged to the user's HMD. The tracking algorithm contextually recognizes the video input and computes the position of the camera in space. This position is registered into a 3D model of the layout, allowing it to be rendered in the direction the user is looking. The user is able to create simple 3D models as envelopes of current elements of the production systems. These serve as so-called colliders—primitive 3D models used for collision computations. Then, the user can place 3D models of machines, workbenches, racks, etc., and evaluate collisions, safety distances and so on. Such tasks are normally performed at an office desk using production line documentation. However, this documentation is often found to be inaccurate, mostly because it is not updated after slight changes are made, or during continuous optimization. This new approach can bypass the need for documentation completely.

A VR platform can open up new opportunities in telecommunications. The concept of telepresence has evolved from videoconferences. It consists of transferring a user's 3D scan or model, making it possible to transmit gestures and expressions. Such a concept is very useful in collaborative problem solving, when participants are geographically distant. Experts can be brought to the site where the problem is without needing to travel, saving a lot of time and money.

Such advantages can be used in production systems planning. There are solutions that stem from distributed collaboration, such as Virtual Collaborative Arena (VirCA) [10], which is a platform for communication between CAVE devices. Users are represented by their avatars, and the problem is modelled in 3D. Various experts can participate in the problem-solving process. VirCA's uses extend beyond production systems planning.

There are advantages in knowledge acquisition when using virtual reality. It has already been proven that VR can be used in various therapies, mainly in psychiatry. It is not that hard to fool human brains by exposure to a virtual environment. This feature is used, for example, in therapies trying to eliminate or at least moderate different phobias using virtual exposure therapy, and goes hand in hand with knowledge acquisition from virtual environments.

The understanding of a situation that is modelled in VR has been evaluated in many studies. There are differences in the kind of virtual reality projection and the quality of the VR hardware. For example, in [11] an Oculus Rift-based VR system is compared to an Nvis SX60 based one. The cost of these devices is very different, with the Oculus Rift being two orders of magnitude cheaper at that time. Although the display quality was better for the Nvis SX60, aimed at the professional market, users estimated lengths more accurately and did better in navigation tasks with the Oculus Rift, which is aimed at domestic use.

Study [12] found that a larger field of view provided by VR devices has a big effect on knowledge acceptance and navigation, even equalling the differences between men and women. In the study, Tan claims that men outperform women when using a VR device with a narrow field of view.

Study [13] compares input devices. In a study with 36 participants, it was found that users interacting with a virtual environment using gestures and touch control performed better than those using a mouse, although they took longer to train.

Study [14] is another interesting study. Participants were divided into three groups, and they were trained in a car service task. One group used a 3D environment on a desktop workstation, the other learned how to perform the task watching a video, and the last group learned by trial and error. After a period of time, they tried to perform the tasks they had learned. It was found that users who had been taught in the 3D virtual environment did better after 2–4 weeks.

Unfortunately, there are also some disadvantages when using virtual devices during training or for performing tasks. Users of VR devices are very prone to suffering from cyber sickness symptoms. Cyber sickness is a set of inconveniencies caused by the discrepancy of acceleration perception. Basically, users see a movement but they do not feel it—exactly the opposite of what happens when travelling in a vehicle. Many articles have been written on the topic of cyber sickness and virtual reality. For example, AR can cause cyber sickness symptoms if users move their head faster than the model registration can be made: study [14] suggests a minimum 1 kHz frame rate for an object that is revolving at 1 revolution per second. This latency has been found to be a problem with AR devices in other studies, such as [15].

Virtual reality is used as a support tool in the education of software engineers. Rather than learning algorithms by calculating equations, students can learn them by designing situations in a virtual environment. Software development kits for various games can be used as platforms for such ideas. Study [16] shows the use of Source Engine (a game engine powering the Half-Life 2 computer game). Software engineers were taught the process of software

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development by making levels for a Source Engine–based game. They worked in a team, and Dr. Emam, the author of this study, claims they learned how to set and accomplish goals in the process collaboratively.

It is clear that virtual reality will find a place in many fields as a novel tool for supporting data visualization, presentation, interaction and collaboration. Back in 2009, when we started to explore how to teach virtual reality at the Faculty of Mechanical Engineering, we found very little information about how to do it effectively. We had to find our own working approach, although we had the advantage of knowing the students and their skills. Searching for other educators' experiences is as difficult today as it was back then. Over the years, we have been refining our methodology for teaching virtual reality. In the following sections, we present the history and the future of our DFVR subject and the DigiTov project.

3. Digital Factory and Virtual Reality

Digital Factory and Virtual Reality, or DFVR, is our subject where we teach the basic principles of virtual reality to mechanical engineering students. Learning how to use this software is very specific because our students have very little or only a basic knowledge of programming, which needs to be brought up to the most basic level sufficient for creating virtual environments. Therefore, we present the DigiTov project and its use in DFVR.

4. DigiTov

Back in 2009, there was a lack of tools to support our virtual reality lessons. Some tools were too complicated, others too expensive, even in with an academic licence, or a combination of both. We needed a tool to enable the students to easily create their own virtual worlds.

We decided to make our own tool using a game engine with a game software developer's kit (SDK). The possibilities were many, although we quickly reduced them to only a few, such as CryEngine or Source Engine. We considered Source Engine the best choice because of the big community of hobbyists around it using the engine to make their computer games, meaning the engine would be simple enough to use.

We decided to use Half-Life 2: Episode Two as our starting point, as it was a modern game with good graphics, an optimized engine and easy to modify. The first step was to find out whether this approach was even possible.

We began by making a validation model. It consisted of a shop floor, which was designed in a Digital Factory project to be an assembly line for radio controlled (RC) car models. This production line's digital mock-up was made in Plavis VisTable® Touch software and balanced using a discrete simulation in Siemens Tecnomatix Plant Simulation programme. We use these tools commercially and we have a database of production line component models in Virtual Reality Modelling Language (VRML) files.

The VRML files were converted using AutoDesk 3dS MAX, where a consistent triangular mesh was made and textures were applied to the models. Using the SMDExport plug-in, SMD files were generated as input for the final step in model conversion: building an MDL file, which can be directly used in a Source Engine game.

The models were built using Valve Hammer Editor (VHE), the official level-editor for Source Engine games—the tools the virtual worlds are created in. New textures and materials were made as we needed them, and the results can be seen in **Figure 2**.

Figure 2. The Half-Life 2 production line validation model. Above is an overall view of the building and parking place. Below is the redesigned production line.

The model was validated successfully. Although we had to overcome some engine limitations, we managed to make an interactive model of an assembly line. Workers play an animation when a part is passing them and the part can be picked up and returned to the conveyor.

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This was the point when the DigiTov (abbreviation of the Czech words 'digitální továrna', or the Digital Factory) was founded. The work to make it a convenient and easy-to-use tool started. More models were converted for use in DigiTov, including machines, more conveyors, storage containers, office furniture, cars and so on. New sets of textures and materials were prepared, and functional blocks of control logic were made into prefabs to be easily deployed in the model and used directly. The final composition of DigiTov can be seen in **Figure 3**.

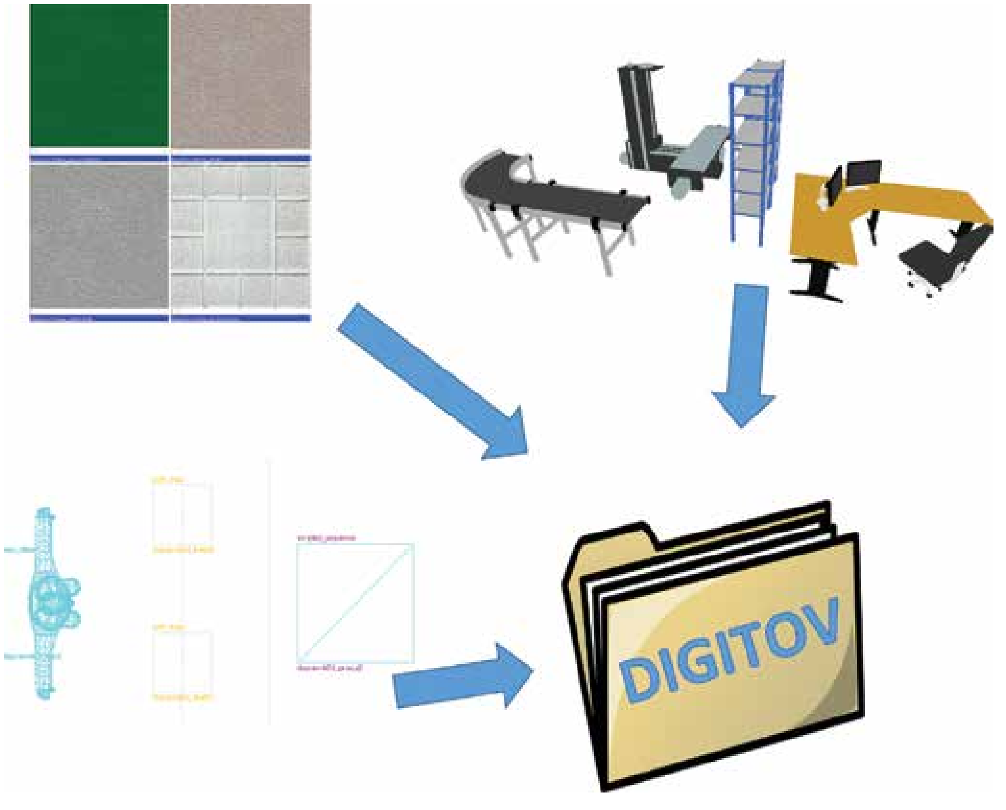

Figure 3. The composition of the DigiTov package.

The DigiTov package was created by a team of students. A total number of 12 authors contributed to making the assets and resources as well as an education e-book, which is a manual for creating models using DigiTov with the VHE level-editor.

In order for DigiTov to be easily used and deployed, a launcher was made in Visual Basic .NET to handle installation, uninstallation, downloading updates and launching models. Manual installation of DigiTov is possible, but it is error prone because the files are manually copied into the correct folders and the configuration files are modified.

Over the 5 years of using DigiTov in classes, new assets have been created by us or by the students. See examples of students' semester projects in **Figure 4**.

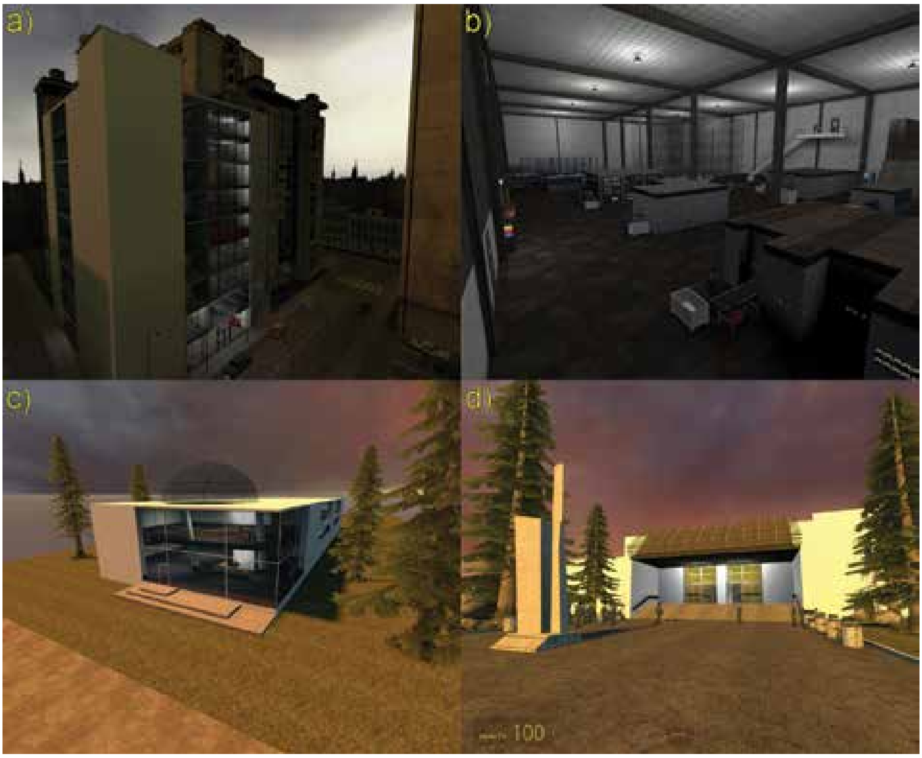

Figure 4. Examples of students' models made with DigiTov: (a) an administrative building inspired by an actual company building in Pilsen, Czech Republic; (b) a virtual reconstruction of an actual shop floor; (c) a fictional company producing automotive parts and (d) the entrance to our faculty.

We not only made an automatic installer and configurator for DigiTov, we also made an automatic converter from a conventional layout designing software product—Plavis VisTable. We encountered conversion problems in some 3D models, so right now the basic layout can be converted successfully, but the user has to check all the converted models manually and adjust lights and some textures.

5. Lectures in DFVR

Our course seems to be different from other VR courses around the world. These courses are still very rare; there are some provided, for example, by the University of Illinois, Stanford University [17] and Ecole de Lausanne [18], but they are all targeted towards IT experts. Our course targets mechanical engineering students who have only basic programming skills. We wanted to keep this programming part, but with lower demands on the students, and also we wanted to present how to work with VR and how it is used in practice. The main target of the subject is to introduce the possibilities of using modern technologies, software and hardware, mainly in the context of manufacturing management. The main paradigms are universal, so

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the outcomes from these subjects can be used generally in other fields. We need to face the fact that all professionals will need to use virtual reality at least at user level. Some of the students will need to communicate with IT experts about this topic.

During the lectures, the students are familiarized with the developments that led to creating the digital factory, its definition and a short history. They learn the importance of topics like Product Lifecycle Management and Mechatronics and the basic benefits of a digital factory. Last but not least, the students are familiarized with software support in this field. Students are introduced to the historical development of the system and the basic technical principles of virtual reality. The possible uses of virtual reality in different fields are also demonstrated.

The first lecture is an introduction intended to raise students' motivation. We start with a discussion. Students usually have certain expectations about the subject, and it is very interesting to ask them for their basic definitions at this point. Each student has a slightly different view of VR at this stage, but at the very end of the discussion we clarify the definition. Students see the outputs of a selection of VR projects carried out at the department in recent years, and then, there is an excursion to the virtual reality laboratory.

The next main topics are:

- **Visualization and haptics**. Students learn about ways to trick basic human senses and how to connect all the aspects and build a CAVE. The last 'entertaining' part of the lecture is about filming stereoscopic movies.
- **Basics of 3D graphics**. This lecture provides a basic theoretical background for the practical part of the subject.
- **Digital factory and Industry 4.0**. Because the subject is part of the Mechanical Engineering programme, we need to have a special focus on modern manufacturing processes management and the use of visualization and virtualization. We explore the new trends which have led to Industry 4.0, such as the Internet of Things and services, Big data management, Simulation, etc. At the very end, we interconnect these aspects with virtual reality.
- **Hardware and motion capture**. Next, we present a little bit of historic, but mainly high end, hardware suitable for VR—starting with expensive solutions and ending with those which are widely available.
- **Augmented reality**. This term is not as widespread as the term virtual reality. The combination of real and virtual elements is now being used mainly for virtual training or as a warehouse management support tool. This lecture introduces the theoretical basis for constructing augmented reality and gives examples of many practical applications.

These are the main topics. We were also able to invite experts from industry to a hosted event, for instance:

- **Use of VR in practice**. This is the first hosted event. An expert who has in-depth experience in industry presents some case studies mainly from the automotive environment.
- **3D scanning**. An expert presents the possibilities of 3D scanning, describes the theory and guides students through the whole process of scanning: data acquisition in the field,

processing point clouds and methods for the acquisition of 3D models. Students can try the whole process on their own: we make a scan of the laboratory and then we process it. We count this activity as a 4 h lecture.

- **Use of virtual reality in psychiatry**. VR has been successfully used as a support treatment for different kinds of phobias and addictions. A doctor with experience from South Korea is the guest for this event.

Other topics have been presented over the 5 years of the course's existence, including Digital Factory and Logistics, Use of VR in Ergonomics with practical examples, and Serious Games.

For the summer school, lectures are simplified and extended using entertainment applications. Some of the lectures are presented not only on this course and SSVR, but as keynotes at the Mechanical Engineering Forum and Science in the Streets. An extended motivation lecture, Industry 4.0, Digital factory and PLM lectures are offered and presented at various high schools in the Czech Republic. Some of these lectures have also been presented at partner universities in Germany, Great Britain, Slovakia and Poland.

6. Practical classes in DFVR

We decided to base the teaching VR on the practical creation of the students' own virtual worlds. We want the students to try to make an interactive application for industry, although they can pick their own topic for their virtual environments.

Up to autumn 2014, we used Valve Hammer Editor (VHE) with DigiTov as the development environment, but we switched to Unity3D last year because, as it is based on Source Engine, DigiTov lacks some features which we would like the students to use.

With DigiTov, we start by carefully explaining the principles of making worlds in Source Engine. The students are taught that the world consists of primitive convex polyhedral solids with 3D models in MDL format. They gradually get to know the entities which carry interactive functions such as doors, lights, etc. and then learn how to use more complex prefabs containing new control logic which are used to make conveyor belts and similar objects found in real factories.

This usually takes half of the course, which is thirteen 90 min sessions. Depending on how fast they are, the basic course is usually completed by the seventh lesson. The rest of the classes are led as workshops—students work alone or in pairs on their projects and we are at their disposal in case they get stuck with anything. In the last lesson, students present their work in our VR lab using a stereoscopic projection wall.

Our university's information system has a module for evaluating courses, and students are asked on a voluntary basis to fill in a questionnaire. It consists of questions about quality that are answered as grades (one worst, five best) and they can also leave comments. Our subject regularly achieves very good scores, between 4.33 and 5.0, and the students very often say that they liked the subject very much because the topics are very current, up to date and interesting.

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They especially appreciate that they have the freedom to choose their semester work topics and that the tool is simple and easy to use, allowing them to focus on the creation of content. There are not many subjects in our Faculty's study programme which are so highly encouraging and allow the students to use their own creativity. We believe that this is the main reason for the good feedback.

As we are trying to make the subject as up to date as possible, we felt that DigiTov was slowly ceasing to support current VR trends such as AR and interactive virtual manuals. Last year, we decided to try Unity3D as the IDE for the student projects.

In contrast to DigiTov, which did not allow any form of scripting by code, it is practically a necessity in Unity3D, except in some specialized cases where prefabs can be found on the Internet or the Unity Asset Store. This proved to be a major issue, because our students have only very basic programming skills in a different programming language—Unity3D uses its own proprietary JavaScript-based UnityScript or a standardized version of C#.

Last semester, we wanted all the students taking the course to form a big development team with different roles. There were coders, modellers, texture makers, sound makers, etc. We guided them in creating the project, but they were not good at coding. Other tasks like designing the virtual environment, getting and using textures and materials, even the sounds, were of good quality. The scripts did not work very well in the final presentation, because scripting is a hard task. The students stated in the questionnaires that they needed more classes explaining C# scripting.

We learned our lesson, and this autumn we are going to prepare the functionality of DigiTov prefabs into Unity3D to be used with as little coding as possible. Another change will be a return back to small teams (1–3 members) and to smaller projects. We are also going to dedicate some classes to augmented reality. We would like to exploit one advantage which mechanical engineering students have: the ability to make CAD models. Our students should be able to focus on creating the 3D models and then bring them to life as easily as possible.

7. Summer school of virtual reality

The Summer School of Virtual Reality (SSVR) is a 3–5 days workshop we organize every summer. Its purpose is to teach young people the principles of virtual reality in an enjoyable way. We began in July 2012, and the participants took lectures in various aspects and principles of virtual reality. We presented our case studies and real virtual projects which we had made. Then, participants were taught how to make their own virtual worlds using the DigiTov.

The students liked the event and we received very positive feedback from them. Following SSVR 2013, two high school students continued using DigiTov in a high school students' practical competition (SOČ), where they won first place at the regional level and seventh place in the European competition.

2016 saw a major innovation. We decided to switch to Unity3D, which is far more capable than DigiTov, although it requires at least basic programming skills.

There is quite a big difference between making a virtual environment in DigiTov and making it in Unity3D. Unity3D is much harder to start with, but practically anything can be programmed. On the other hand, DigiTov allows only a first person walkthrough with limited scripted scenes and interaction and does not allow scripting by writing code and using variables.

We taught the students how to make a virtual environment from the very beginning, from placing objects and writing simple scripts to making more complex models in SketchUp modelling software and importing them to Unity3D afterwards. On the second day, we continued making simple walkthrough games and tried to port them to the Oculus Rift DK2 head set, which unfortunately was unsuccessful, probably due to the incompatibility of the version.

On the third day, we taught the use of prewritten scripts and showed examples of codes we had written for other projects: state machines, controllers, animations, etc. In the afternoon, we let students work alone on their own projects and we were at their disposal in case they got stuck with any technical problems.

At the end of each day, participants were asked to fill in a questionnaire. There were a few questions to evaluate what they had liked the most and the least, what they had learned, etc. The results are shown in the graphs in the following figures.

Among other questions that were answered very positively, these two shown in the graphs are the most important for us. Unity3D is very hard to begin with, and 3 days (8 h each day) is hardly sufficient to teach the basics. Overall, the grades dropped on the second day (see **Figure 5**), which we believe was due to the failure of the Oculus Rift porting and that the portion of things taught had to increase rapidly. The last day was a success, and most of the students managed to make a 3D platform or maze game. We are pleased with **Figure 6**—it is proof that we managed to teach the participants of SSVR the principles of virtual reality. All of them now consider themselves to be lower intermediate level.

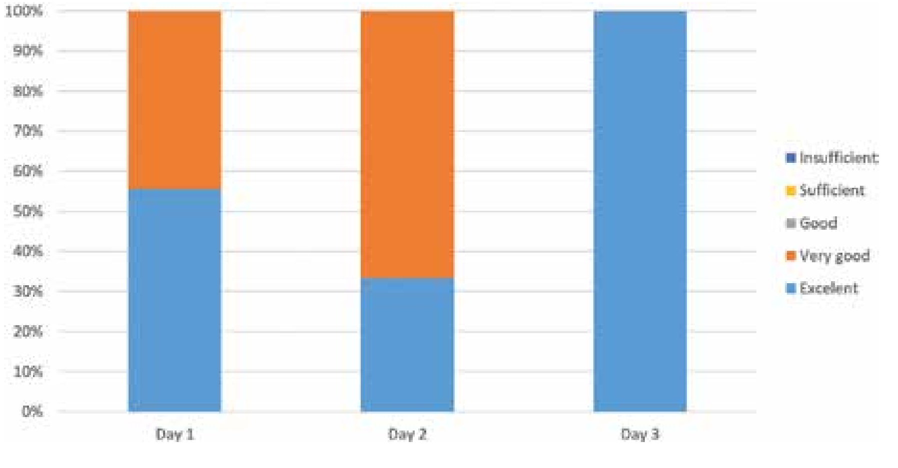

Figure 5. Answers from the questionnaire: 'How would you evaluate this day? Use grades, like at school.'

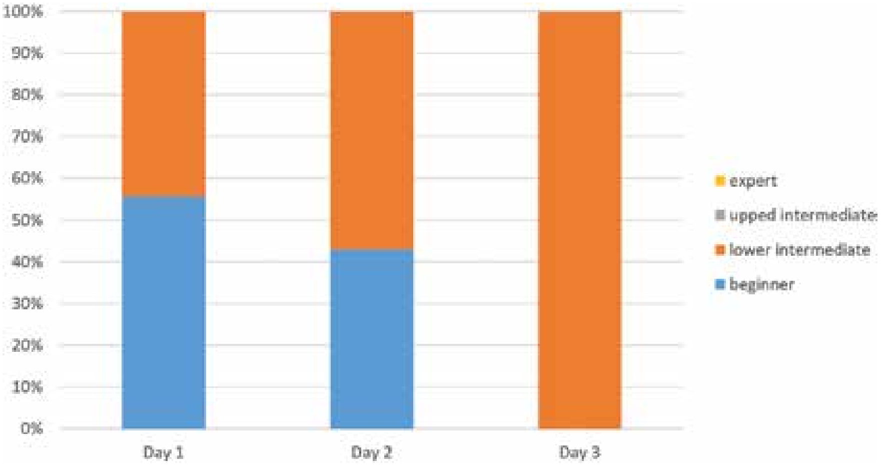

Figure 6. Answers from the questionnaire: 'How experienced do you consider yourself in virtual reality?'

We wrote code snippets on the projector, but the students claimed it was too hard and too fast for them to catch. In the future, we are definitely going to prepare more complicated scripts and explain them rather than write the scripts in front of them. Some students even suggested such approach.

Looking back at the SSVR, the approach of teaching VR in Unity3D is a good idea, but Unity3D is not an easy tool to start with. A slower approach would be better, and we will provide the students with prewritten scripts which they can use simply, assign variables and directly try the results. This was an event for engaged enthusiasts, and they were always delighted when they saw their virtual worlds working.

8. Other outputs

DigiTov is not the only unique output from DFVR. Other interesting studies arising from the subject included special semestral work and a start-up for a collaboration with particular students (for a thesis in most cases). Students also helped and participated in a study exploring knowledge acquisition and cyber sickness, published in [19].

Figure 7 shows some outputs from selected projects and studies made in collaboration with students.

a. **Minnesota Dexterity Test (MDT) comparative study**. Some companies use tests at assessment centres when hiring new staff. One of these is the MDT test for jobs where manual speed and accuracy are required. We made a virtual version of this test and compared our results with results from a conventional test.

b. **Virtual workshop**. This is a serious game which is currently used as a support SW tool for learning the basics of manufacturing.

c. **Augmented reality for training**. We developed a system where a worker receives complete instructions for assembly on a monitor accompanied by a real-time video feed (published in [20]).

d. **Game—training in industrial engineering methods**. This is a full-scale 2D computer game. The gamer/student plays the role of manager for the first day, and the task is to solve a range of manufacturing problems using industrial engineering methods such as KANBAN, JIT, 5WHYS, etc.

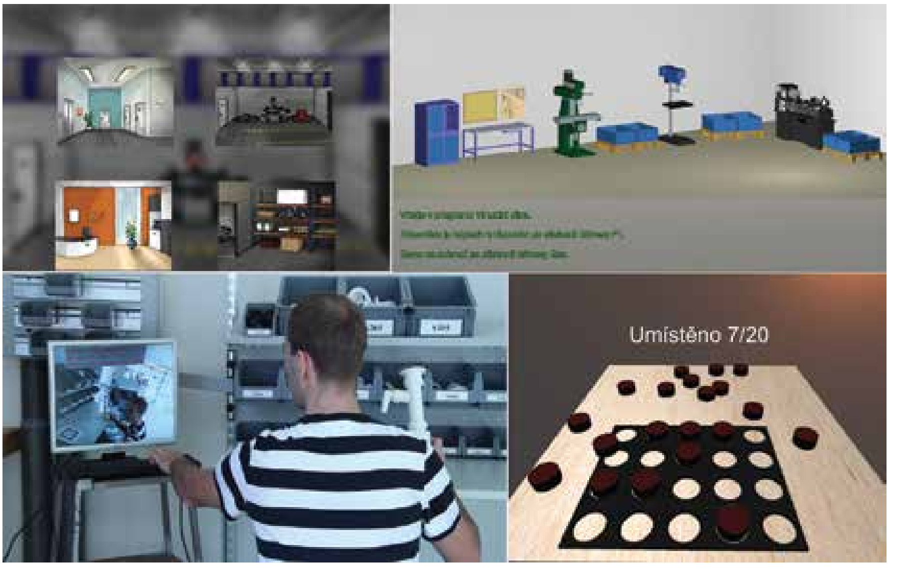

Figure 7. Other case studies and projects.

9. Conclusion

Bringing DFVR to life has been a long process. It took 2 years of intensive work to prepare, during which we created a basic version of DigiTov, and this was later extended by another 3 years. We launched a website for this subject and also developed two interactive e-learning books. The first book provides direct support for the lectures and contains more than 80 videos, 400 illustrations and 200 pages of text. The second is a multimedia e-book for working with DigiTov (200 pages). Students can also download all the lecture presentations (5 GBs) and further examples of finished models.

We also used this approach for the summer school of virtual reality which is primarily targeted at high-school students. Last year (10 days in 2015), students made their very own 3D game (using DigiTov) and also a 2D adventure game. This year (2016) students made their very own outdoor game with their own 3D models and level design. The results were ported to CAVE and Oculus Rift.

http://dx.doi.org/10.5772/65218

The completed student models are presented to basic schools, high schools and universities. We have also used the outputs at different events such as Science on The Streets, Popular Project (presentations and lectures at high schools), Education Expo, etc.

The evaluation process was carried out each year, the course receiving positive feedback from students. They primarily appreciate the topicality of the subject, the interconnection between theory and practice and the possibility to immerse themselves in their own virtual reality.

In the future, we would like to stick to a given concept with a few changes. We have recently started to use Unity3D, which offers more possibilities, but using it is more challenging. Students will have total freedom of creativity with all options open to them. For instance, Unity3D allows multiplatforming, which means, for example, development for iOS and Android.

After applying this approach, we found that some students who have only one or two semesters of programming had difficulties in event-driven real-time programming, which is essential for virtual reality development. This time we assigned these students the roles of graphic designers, sound editors and designers. In the future, we would like all of them to try basic virtual world development as in previous courses. To this end, we started to develop the port of DigiTov into Unity3D. This time we 'translated' more models from DigiTov, some of them are now 'intelligent' and have more action scripts included, which can be user controlled, combined and triggered (see **Figure 8**).

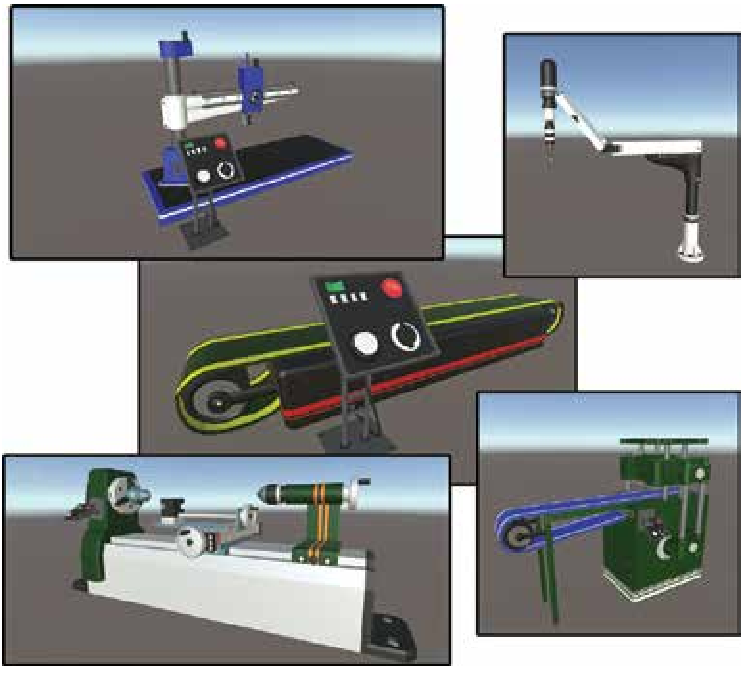

Figure 8. New 'smart' machines.

Acknowledgements

This chapter was prepared with the support of the Internal Science Foundation of the University of West Bohemia SGS–2015-065.

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Edited by Dragan Cvetković

The first chapter provides an overview of the popular systems for distance learning. In the second chapter, a review of all major social and economic activities in order to improve the system of virtual learning is given. The third chapter deals with the influence of technology in the management of educational institutions. The fourth chapter provides an overview of the graphic communication. The fifth chapter confirms that quality assurance remains an integral and indispensable part of the process of virtual learning. The sixth and seventh chapters are dedicated to health and mutual communication about health problems and causes. The eighth and ninth chapters are dedicated to massive open online courses (MOOC). The tenth chapter refers to the widespread use of virtual reality in industrial environments.

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ISBN 978-953-51-4136-5