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Message from the
International President

Dear SIEC-ISBE Friends,

Welcome to the 157th edition of The *International Journal for Business Education*, formerly known as *The Review*. Our journal is a double blind, peer-reviewed publication for global business educators by global business educators. The journal is published once per year. ISBE members provide in-depth research articles that can be helpful in the classroom or with administrative responsibilities. Each article, based upon research conducted by our members, adds to the body of knowledge in global business education. As in the past, a brochure for the upcoming conference will be included.

I want to thank Tamra Davis, Ph.D. of the USA Chapter and Michaela Stock, Ph.D. of the Austrian Chapter for taking on the task of editors. I also want to take a moment to thank our reviewers. The complete list of reviewers can be seen on our Editoral Board page. Your expertise was beneficial in helping improve the quality of the accepted manuscripts and offering guidance for improvement to those authors whose work was not accepted this year.

Our international conference will be located in San Juan, Puerto Rico. The conference theme, Internationalization of Education: A Why and How Perspective, is an exciting theme that is very appropriate as our organization celebrates 116 years of excellence in Business Education. I hope to see you at the 2017 conference and our future conferences as well. Future conferences are planned in the following locations:

2018—Reykajvik, Iceland

We are seeking proposals for conferences in 2019 and beyond.

With warmest SIEC-ISBE regards until we meet again,

Petra Bragadottir
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Review Process

The International Journal for Business Education is a double-blind, peer-reviewed journal. Due to the international nature of the journal, two or more editors work together to facilitate the review process. The editor from outside of the United States handles all manuscripts that originate from the United States. This editor assigns the manuscripts to the appropriate reviewers, handles all correspondence with the author(s) and reviewers, and makes the final decision on acceptance. The editor from the United States handles manuscripts that originate from outside the United States. Again, this editor assigns the manuscripts to the appropriate reviewers, handles all correspondence with the author(s) and reviewers, and makes the final decision on acceptance. By following this process, it is possible that one or more of the editors will also have a manuscript published in the journal. Additionally, it is also possible that someone who has submitted a manuscript is also selected to be a reviewer.

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Preface

We would like to thank the wonderful professionals who filled the role of reviewers for this year's journal. Due to the number of manuscripts received, multiple reviewers were needed. Without their assistance, the job of editor would have been much more difficult. Thank you to the entire Editorial Board who are SIEC-ISBE members and volunteered to help when asked. Thank you.

We hope that you find the articles included in this year's The *International Journal for Business Education* interesting. Thank you to everyone who submitted a manuscript for consideration. Without your submissions, we would not have had a journal.

Tamra S. Davis, Ph.D. and
Michaela Stock, Ph.D.
SIEC-ISBE Editors 2017

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The Relationship between Classified Difficulty and Implausible Distractors in Multiple-Choice Questions

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ABSTRACT

Published banks of multiple-choice questions are ubiquitous, the questions in those banks often being classified into levels of difficulty. The specific level of difficulty into which a question is classified might or should be a function of the question's substance. Possibly, though, insubstantive aspects of the question, such as the incidence of incorrect answers that are readily dismissed, also affect the difficulty level into which a question is classified. The present research investigates the relationship between classified question difficulty and the incidence of implausible incorrect answer options.

Introduction

Assessment of teaching and learning is not a new idea, but it has gained increased importance in the last two decades. This is primarily due to increased demands of accountability by funding organizations (e.g. governments) and requirements by accreditation associations (Bollag 2006; AACSB 2013a). The Association to Advance Collegiate Schools of Business (AACSB), for example, has integrated assessment, what they call assurance of learning, as a critical component of accreditation standards. Per AACSB, assurance of learning is defined as, "… processes for demonstrating that students achieve learning expectations for the programs in which they participate" (AACSB 2013b, p. 29). This makes intellectual sense as the students should be receiving what they pay for in terms of their education.

Multiple choice exams are a common method for evaluating student learning and can be used as an assessment tool (Santos, Hu, and Jordan 2014). These exams have the benefit of being easy to distribute and grade. Questions in published multiple-choice question banks are commonly classified into three levels of difficulty. "One of the most important responsibilities of the [instructor] is to define the level and the distribution of the difficulties of the items that are to compose the final test" (Tinkelman 1971, p. 62). With this, instructors might well rely on the published difficulty classifications when constructing an exam. Thus, instructors have a fundamental interest in the validity of the published classifications. In turn, serving that interest is the responsibility of those who write and classify questions. (It is possible too, of

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course, that instructors themselves might analyze published questions and refine or discard them accordingly.) Since publishers rarely describe how questions are classified, the validity of those classifications is difficult to assess. One available means, though, is through the analysis of certain elements of the questions; specifically, the incorrect answer options, i.e., distractors, and the (im)plausibility of those distractors. A question may to be classified as, *easy*, not because the object of the question is easy because the question stem and correct answer are purposely framed, to provide cues. Instead, the classification is selected because of the insubstantive aspect that some of the distractors are so obviously incorrect that they do not serve their purpose of attracting responses from students who do not know the correct answer.

The present research used samples from selected question banks, and shows there does exist a relationship between classified difficulty and the presence of implausible distractors. Implications are that those who write and classify published questions might be mindful of this relationship when composing distractors in the first place and then strive to ensure that the question difficulty classification is not simply due to the presence of implausible distractors. For particular question banks, question writers/publishers might conduct analyses similar to those in this research prior to publication. The analysis may focus on not only the percent of correct responses, but also more broadly on distractor responses. Those analyses, too, can be ongoing after publication with the goal of refining subsequent editions of question banks. Likewise, for a particular bank of interest, instructors might also conduct such analyses. This could be for the purpose of refining/discarding questions, but also more broadly as a measure of the validity of the published question bank with an eye to continuing or discontinuing its use.

Background

Distractors (or foils or misleads), i.e., the incorrect answer options, are an integral component of multiple-choice questions. As such, distractors play a major role in determining the properties of the questions. "The content of an item can be altered radically by changing the distractors, while keeping the correct response the same" (Cronbach 1971, p. 454). The essential purpose of distractors is to attract responses from examinees who do not know the correct answer. Distractors that fail to distract, then, do not serve their basic purpose.

> The key [to distractor analysis] is to examine each distractor and ask two questions. First, did the distractor distract some examinees? If no examinees selected the distractor it is not doing its job. An effective distractor must be selected by some examinees. If a distractor is so obviously incorrect that no examinees select it, it is ineffective and needs to be revised or replaced. (Reynolds & Livingston 2012, p. 233)

Recognition of the importance of effective distractors is widespread. "Make all distractors plausible and attractive to examinees who lack the information or ability tested by the item" (Wesman 1971, p. 116). (Later paraphrased by Millman & Greene [1989, p. 353]: "Make all

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options plausible and attractive to examinees who lack the information or ability referenced by the item.") "Distractors that are hardly ever chosen are too transparently incorrect and can be omitted or, preferably, replaced" (Nunnally & Bernstein 1994, p. 301) and, "...adding distractors that fail to distract cannot improve the utility of the item" (Wesman 1971, p. 100). "In multiple-choice tests he [the test writer] learns which distractors (wrong answers) or misleads are not functioning, as shown by their relative unpopularity" (Guilford 1954, p. 417)

The common implication of these observations is that implausible distractors compromise the essential effectiveness of multiple-choice questions. The more specific compromise in the present research is the material degree to which obviously incorrect answers and published question difficulty classifications are related. That is, to some material extent, the published classifications appear to be a function of some distractors not serving their essential purpose. This, in turn, implies a need for greater care in writing effective distractors originally and refining ineffective distractors from one edition of the question bank to the next edition.

This recognized importance notwithstanding, Dickinson (2013) has shown that for samples of questions from several question banks there is a substantial presence of ineffective distractors. Across five question banks, the percent of sample questions having at least one distractor attracting no responses ranged from 53.53% to 70.89%. The percent of questions with at least one distractor attracting ten percent or less of total responses ranged from 97.02% to 99.16%.

The primary implication of the use of implausible distractors is that the measurement of examinees is compromised. "This [measuring students' levels of comprehension] does not result if the test questions are such that little real knowledge is needed by the testee because of the ease of eliminating ridiculous or remote possibilities in the incorrect choices" (Weitzman & McNamara 1946, p. 517)

Implausible distractors, then, are one basis of the present research. Banks of multiple-choice questions accompany most introductory level textbooks in business. The questions, typically, are classified into three levels of difficulty–*easy, medium, hard*–and often on other dimensions such as skill type. Those classified levels of difficulty are the second basis of the present research. The specific focus is to investigate, in selected banks of questions, whether classified level of difficulty is related to the presence of implausible distractors.

Various scenarios might lead to such a relationship. In classifying a given question, the question writer may consider what he/she deems to be the effectiveness of its distractors. Possibly, too, the writer may actively construct the effectiveness of distractors toward some desired difficulty level. Perhaps a question is classified without conscious regard for its distractors, yet the distractors exert a subtle influence nevertheless.

The essential effect of implausible distractors is to render a question easier to answer. Fundamentally, then, it was hypothesized that the number of implausible distractors and the

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published classified difficulty of a question would be inversely related.

Data

Multiple-choice question banks accompanying six texts were examined. Among the six were two editions of a consumer behavior text plus a second consumer behavior text and three editions of a retailing text. The texts, the total number of multiple-choice questions in the respective banks, and the number of questions sampled from each question bank are reported in Table 1.

Table 1
Bank and Sample Question Counts

Text	Total Questions	Sample Questions	Percent of Total
Levy, Weitz, & Grewal (2014, LWG), *Retailing Management*, Ninth Edition	1229	307	25
Levy & Weitz (2012, LW), *Retailing Management*, Eighth Edition	1211	624	51.5
Solomon, Zaichkowsky, & Polegato (2011, SZP), *Consumer Behaviour*, Fifth Canadian Edition	1148	671	58.4
Levy & Weitz (2009, LW), *Retailing Management*, Seventh Edition	1332	736	55.3
Solomon, Zaichkowsky, & Polegato (2008, SZP), *Consumer Behaviour*, Fourth Canadian Edition	1019	674	66.1
Hawkins, Mothersbaugh, & Best (2007, HMB), *Consumer Behavior*, Tenth Edition	1624	958	59

Courses.

Providing data for the present analyses were undergraduate courses in retailing and consumer behavior typically taken in the third year of a student's university program. Both courses have prerequisites of two semester-long principles of marketing courses. The same instructor taught all classes on a project basis. During the time under study, no changes to the course format, content or methodology occurred.

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Examinations

For each class the first exam covered approximately the first third of the chapters, the second exam covered about the middle third of the chapters, and the noncumulative final exam covered the last third of the chapters. Reflecting the project basis for both courses, exams were based solely on the assigned textbook. That is, exams entirely comprised multiple-choice questions drawn from the published question bank.

Each of the exams counted for 20 percent of the students' final course grades (the project counting for the remaining 40 percent). Exams were scored as the percent of questions answered correctly; no penalty was deducted for incorrect answers. In the very few instances where multiple answers were given, those questions were excluded from the present research. Numbers of exams and students are reported in Table 2.

Table 2
Exams and Students

Text (de-identified)	Student-Exams [a]	Questions per Exam [b]	Students per Exam [b]	Score [b]
LWG (2014), 9th	260	51.2	43.3	73.3
LW (2012), 8th	456	52.3	38.0	69.5
SZP (2011), 5th	503	55.9	41.9	58.2
LW (2009), 7th	434	61.3	36.2	67.4
SZP (2008), 4th	479	56.2	39.9	61.1
HMB (2007), 10th	588	53.2	32.7	62.7

a A student-exam is one student taking one exam.
b mean

Sampling Method

Multiple-choice questions are arranged in the test question bank per the order in which the question content appears in the textbook. For each examination, specific multiple-choice questions were selected on a systematic sampling basis. Questions were sampled on a chapter-by-chapter basis. Parameters guiding the sampling were a total of 50-60 questions per exam (in light of the 90-minute class period), the total number of published questions for the chapter, and the anticipation that the text would be adopted for a certain number of classes within and across successive semesters.

For example, for the first exam of a given text, the first question in the chapter was selected followed by every n-th question. Consider a chapter having 80 published multiple-choice questions and the anticipation that questions from the text eventually would be drawn for six classes. For the first exam, the first question in the chapter was selected followed by every n^{th}

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question. For the example parameters just given, n equaled 9 and questions 1, 10, 19, 28, 37, 46, 55, 64, 73 were for the first exam. For the sixth exam, questions 6, 15, 24, 33, 42, 51, 60, 69, 78 were selected. Within a given question bank, no questions were repeated across exams.

This systematic sampling approach was an attempt to ensure that:

- a cross section of each chapter content was included among the examination questions,
- all respective midterm and final examinations were of comparable composition, and
- a representative sample of the text bank questions was obtained.

Counts of test bank and sample questions are reported in Table 1. All questions analyzed had five answer options: the correct answer plus four distractors.

Analysis

The purpose of this research is to investigate whether classified question difficulty level and the incidence of implausible distractors are related. Classified question difficulty level is drawn from the published question bank. Distractors attracting no or few responses were measured in three ways for each question:

- The number of distractors attracting zero responses. (Where all four distractors attracted zero responses, all students answered the question correctly.)
- The number of distractors attracting less than or equal to 5 percent of total responses (the total including correct responses).
- The number of distractors attracting less than or equal to 10 percent of total responses.

Percentages of questions with distractors attracting each of the three levels of implausibility are reported in Table 3.

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Table 3
Percent of Questions by Level of Implausible Distractors (count)

Text	0%	≤5%	≤ 10%
LWG (2014), 9th (n=307)	68.7 * (n=211)	90.6 (n=278)	99.3 (n=305)
LW (2012), 8th (n=624)	72.4 (n=452)	91.5 (n=571)	98.9 (n=617)
SZP (2011), 5th (n=671)	53.4 (n=358)	86.3 (n=579)	97.0 (n=651)
LW (2009), 7th (n=736)	70.2 (n=517)	91.4 (n=673)	99.0 (n=729)
SZP (2008), 4th (n=674)	56.1 (n=378)	85.0 (n=573)	97.6 (n=658)
HMB (2007), 10th (n=958	67.0 (n=642)	91.5 (n=877)	99.2 (n=950)

* 68.7 percent or 211 of the 307 sample questions had at least one distractor that attracted zero percent of student answers.

The type of analysis was rank correlation, using each of the above three operational definitions of implausible distractors separately. The data were first organized into cross-tabulation tables, the rows comprising published question difficulty level–*easy, medium, hard*–and the columns comprising the number of qualifying distractors–ranging from 0 to 4. These tables may be seen to be ordered contingency tables and analyzed accordingly (Gibbons 1993, pp. 60-80).

Numerous measures of rank correlation for ordered tables are available. Perhaps the most commonly used is Spearman's rho and that is reported here. (As with rho, all the other available types of rank correlations were negative – as was hypothesized – and were statistically significant, $p<.001$.)

Both the rows and columns of the ordered table are arranged in ascending order. The rows are arranged in order of increasing difficulty. The columns are arranged in order of increasing ineffectiveness. With this arrangement, the correlation between classified question difficulty and the effectiveness of its distractors was expected to be negative.

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Results

Table 4 presents the rank order correlations between published difficulty classification level (1 to 3) and the number of distractors (0 to 4) attracting the noted percent of responses. (The percent of responses is based on all responses, including responses to the correct answer option.)

Table 4
Spearman Rho Rank Correlations between Classified Question Difficulty and the Number of Implausible Distractors

Text	0% [a]	≤ 5% [b]	≤ 10% [c]
LWG (2014), 9th	-0.0692 **	-0.0961 *	-0.0717 **
LW (2012), 8th	-0.1593	-0.2187	-0.1655
SZP (2011), 5th	-0.2426	-0.3342	-0.3144
LW (2009), 7th	-0.2317	-0.2739	-0.2335
SZP (2008), 4th	-0.2456	-0.2981	-0.3554
HMB (2007), 10th	-0.2159	-0.2502	-0.2690

a Implausible distractors defined as those attracting 0% of responses.

b Implausible distractors defined as those attracting ≤5% of responses.

c Implausible distractors defined as those attracting ≤10% of responses.

All one-tail p-values < .001, except * p<.05, and ** p<.12

Except for LWG (2014) all the correlations are highly statistically significant (one-tail p-value < .001). Though approaching statistical significance, the larger p-values for LWG (2014) may be a function of the relatively smaller sample of questions from that bank. Possibly, too, they may reflect a refinement of the questions in that edition of the question bank. The correlations are material, with all but five having absolute values greater than 0.20. For these samples of multiple-choice questions, published classified difficulty and the number of implausible distractors are related.

Discussion

The results of this study show that, for the samples of question banks analyzed, published classified question difficulty and the number of implausible distractors are (inversely) related.

Normatively, plausible distractors should affect question observed or measured difficulty (Dickinson 2015). Here, though, it is implausible or ineffective distractors that are related to

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classified question difficulty. Ineffective distractors have several undesirable implications as noted earlier. Instructors relying on classified question difficulty to compile exams might be cautioned that the classification is partly due to an undesirable property of the questions.

Question writers might be similarly cautioned, though writing distractors is difficult, as is recognized by many. "The major short-comings of multiple-choice questions are, first, the difficulty of writing good distractor options . . ." (Gregory 2011, p. 140). "When an individual item is being written, the number of potentially meaningful, relevant distractors is far more limited [than the universe of items]; the law of diminishing returns very quickly takes over . . . the search for good distractors *after* three or four good ones have already been found is likely to be frustrating and fruitless" (Wesman 1971, pp. 99-100). ". . . preparation of an additional distractor may well require disproportionate additional effort on the part of the item writers" (Tinkelman 1971, p. 74). "The use of five alternatives is probably the upper limit . . . due to the difficulty in developing plausible distractors..." (Reynolds & Livingston 2012, p. 198).

The results of this research, of course, do not necessarily hold for all published banks of multiple-choice questions. There exist any number of guides for writing multiple-choice questions (Gregory 2011, p. 140; Haladyna 2004; Reynolds & Livingston 2012, pp. 197-202; Wesman 1971). The many different question writers, though, are not necessarily in lock-step with those guides. Nor do those guides encompass relevant human characteristics of item writers such as subject expertise, ingenuity, empathy with target students, and straightforward expression.

The consistency of the results across the several test banks (those of multiple editions no doubt having several duplicated questions), though, suggests some reliability of the findings.

Data for replicating this research are plentiful and easily obtained. Such replication might further support (or not) the essential result of this study. In addition, publishers might carry out similar investigations of their question banks. Many texts publish periodic editions (LWG being in its ninth edition, SZP now being in its sixth edition, and HMB now being in its thirteenth edition). Refining the distractors (or other properties) of multiple-choice questions from edition to edition would soon see improved question banks, of benefit to publishers specifically and pedagogy generally.

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Life-cycle assessment (LCA) creates new possibilities for entrepreneurs to influence the environmental impact

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ABSTRACT

This paper discusses the Life-cycle Assessment (LCA) and its possibilities for entrepreneurs to influence environmental impact.

LCA is a technique to assess environmental impacts associated with all the stages of a product's entire life from cradle to grave, i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. LCA can help to analyze and compare the environmental impact of products or services via an inventory of energy and material inputs and emissions at all stages. LCAs focus on environmental impacts and originally do not consider social or economic impacts.

The first case study presents the philosophy and thinking model for the LCA technique. Two products, T-shirts, which have been dyed by two different methods: a conventional model and a method based on biotechnology have been compared by Ms. Anne Nielsen and Mr. Per Nielsen at Novozymes A/S.

Another case study by Levi Strauss & Co. presents their outstanding progress innovating around water reduction in denim manufacturing, including creation of the Water<Less™ process and implementing the apparel industry's first Recycle/Reuse standard.

By assessing environmental impact associated with all the stages of a product's life, it makes possible for LCA to create new possibilities for both existing entrepreneurs and for business and engineering students.

Aim of the Paper

The purpose of this study is to examine the Life-cycle Assessment (LCA) and its possibilities for entrepreneurs to influence environmental impact. LCA gives a competitive tool for entrepreneurs to analyze that impact. The core process for LCA investigation is presented in Figure 1. Even the cost burden and marketing issues can be included to the analysis to guide the decision-making.

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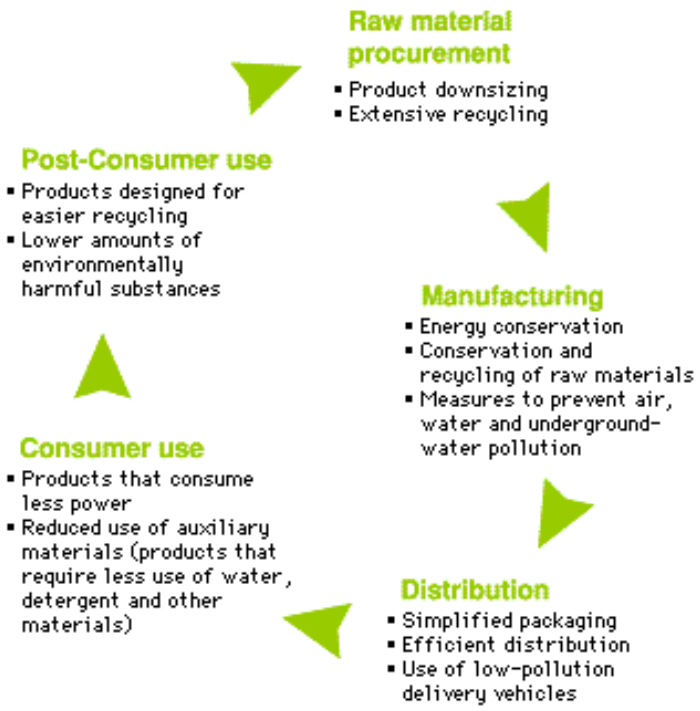

Figure 1. Life cycle assessment process.
Matsushita Graphic Communications Systems, Inc.

Contribution to the Literature

The basic principle of life cycle thinking is that the environmental impacts of a product include not only the environmental impacts of the manufacturing process, i.e. direct impacts, but also all the environmental impacts that a product has at other stages of its life both before and after manufacture, i.e. indirect impacts. The objective is to establish the impacts that result from the manufacture and use of a product. Life cycle thinking has changed people's understanding of environmental impacts and the way in which environmental impacts are studied. It also forms the basis of many national and international sustainable development and environmental policies and has become a widely recognized approach to dealing with environmental issues. In addition to standardized life cycle assessment (International Organization for Standardization, ISO 14040, 2006a), there are several other methods for evaluating environmental impacts that are based on life cycle thinking these days. Simplified footprint calculation tools have been adopted in recent years, which focus on specific environmental impacts or emission classes, such as water, carbon or phosphorus footprints (Finnish Environment Institute SYKE, 2014). Global warming, agricultural land use, eutrophication and use of different chemicals are also often included in reports based on life cycle philosophy (Nielsen & Nielsen, 2009).

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LCA connects people from business, government, non-profit and international organizations, investors and academics to create a dynamic learning community to escalate change in possibilities for entrepreneurs to influence environmental impact (Water Footprint Network, 2016).

Methodology

The theoretical framework consists of theories dealing with environmental effects assignable to products and services by quantifying all inputs and outputs of material flows and energy and assessing how these material flows and use of energy have an impact of the environment (Cooper & Fava, 2006).

The research approach is qualitative and is based on case studies and expressed by rules in the ISO 14040 (International Organization for Standardization, ISO 14040, 2006).

The first case study presents the philosophy and thinking model for the LCA technique. The case study compares two T-shirt products. The T-shirts have been dyed by two different methods: a conventional model and a method based on biotechnology (Nielsen & Nielsen, 2009).

Another case study by Levi Strauss & Co. presents their outstanding progress innovating around water reduction in denim manufacturing, including creation of the Water<Less™ process and implementing the apparel industry's first Recycle/Reuse standard (Levi Strauss & Co., 2015).

Life Cycle Assessment

What is Life Cycle Assessment?

Life Cycle Assessment (LCA) is a tool for the systematic evaluation of the environmental aspects of a product or service system through all stages of its life cycle. LCA provides an adequate instrument for environmental decision support. Reliable LCA performance is crucial to achieve a life-cycle economy.

The International Organization for Standardization (ISO), a world-wide federation of national standards bodies, has standardized this framework within the series ISO 14040 (2006) on LCA. ISO 14040/44 are the globally accepted standards for life cycle based environmental assessments. The leading position has been striven to keep as the only globally relevant standard in the field. There is the growing use of ISO 14040/44 inside and outside ISO/TC207, Technical committees, Environmental management in ISO. Much work has been done towards applying, improving, deepening and broadening of the core standards.

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The LCA consists of (see Figure 1).

- Raw material procurement
- Manufacturing
- Distribution
- Consumer use and
- Post-consumer use

Through this process, it is possible to share more information about the environmental impact of the products with both consumers and the factories that make these products — adding a completely new level of transparency. Consumers have more power to shop based on values, while suppliers gain the opportunity to continue collaborating with companies on ongoing improvements in environmental performance.

The Phases of Life Cycle Assessment

Life-cycle assessment has emerged as a valuable decision-support tool for both policy makers and industry in assessing the cradle-to-grave impacts of a product or process. Three forces are driving this evolution. First, government regulations are moving in the direction of "life-cycle accountability;" the notion that a manufacturer is responsible not only for direct production impacts, but also for impacts associated with product inputs, use, transport, and disposal. Second, business is participating in voluntary initiatives, which contain LCA and product stewardship components. These include ISO 14000 and the Chemical Manufacturer Association's Responsible Care Program, both of which seek to foster continuous improvement through better environmental management systems. Third, environmental "preferability" has emerged as a criterion in both consumer markets and government procurement guidelines. Together these developments have placed LCA in a central role as a tool for identifying cradle-to-grave affects both products and the materials from which they are made (International Organization for Standardization, ISO 14040, 2006a).

Four linked components illustrate the various phases of LCA (See Figure 2).

1. Goal and Scope Definition, the product(s) or service(s) to be assessed are defined, a functional basis for comparison is chosen and the required level of detail is defined;
2. Inventory Analysis of extractions and emissions, the energy and raw materials used, and emissions to the atmosphere, water and land, are quantified for each process, then combined in the process flow chart and related to the functional basis;

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3. Impact Assessment, the effects of the resource use and emissions generated are grouped and quantified into a limited number of impact categories which may then be weighted for importance;
4. Interpretation, the results are reported in the most informative way possible and the need and opportunities to reduce the impact of the product(s) or service(s) on the environment are systematically evaluated. (United Nations Environment, 2009, p. 34)

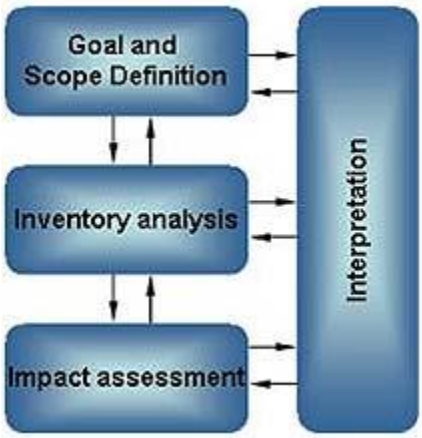

Figure 2. Four linked LCA Components

The calculations of the process are made by using special software. SimaPro is one of the oldest software tools; nowadays, there are many tools specified on a group of products, different materials and different forms of services. Some other tools include GaBi, Umberto, Ide-Mat. More information about the life-cycle assessment can be found at https://en.wikipedia.org/wiki/Life-cycle_assessment.

Case studies

Case Study 1: T-shirts.

Case study 1 presents the philosophy and thinking model for LCA technique. Two products, T-shirts, which have been dyed by two different methods: a conventional model and a method based on biotechnology. Shifting from conventional textile dying and treatment to the new elemental process saves energy and water. The process temperature can be significantly decreased as well as the production time and several baths have been avoided. Furthermore, the applied amounts of some chemicals are reduced.

The magnitude of the savings depends of the way in which the energy is produced and consequently also of the amount of flue gases produced by the process. The savings have an

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impact on the global warming, acidification, eutrophication and on other impact categories (Nielsen & Nielsen, 2009).

Case Study 2: The lifecycle of a Jean by Levi Strauss & Co.

At Levi Strauss & Co, the focus is to build sustainability into everything they produce. To that end, they conducted the apparel industry's first LCA study in 2007 to assess the full environmental impact of a core set of products from cradle to grave. The study found that the greatest water and energy impact was in two areas: cotton cultivation and consumer use.

Since then, they have made outstanding progress innovating around water reduction in denim manufacturing, including creation of the Water<Less™ process and implementing the apparel industry's first Recycle/Reuse standard.

Levi Strauss & Co. has saved 1 billion liters of water since 2011 through the Water<Less™ process, which reduces the water used in garment finishing by up to 96 percent. They have also taken bold steps to reduce the environmental impact of our products in areas outside their direct control through our Care Tag for Our Planet initiative and by working with the Better Cotton Initiative® (BCI).

In 2015, Levi Strauss & Co. released a new global lifecycle assessment study, an update on the 2007 study that examined the environmental impact of their Levi Strauss & Co. products. The new study analyzed the complete product lifecycle, probing deeper into the environmental impacts of cotton in key growing regions, apparel production and distribution in a range of locations, and consumer washing and drying habits in key markets.

The study shows that of the nearly 3,800 liters of water used throughout the lifetime of a pair of jeans, cotton cultivation (68%) and consumer use (23%) continue to have the most significant impact on water consumption. Consumer care is also responsible for the most significant energy use and climate impact, representing 37 percent of the 33.4 kilograms of carbon dioxide emitted during the lifecycle of a jean.

The new LCA expands on previous research to better understand the impact of cotton cultivation and includes data from the world's primary cotton producing countries, including the United States, China, Brazil, India, Pakistan and Australia. It also analyzes consumer care data from new markets, including China, France and the United Kingdom, to understand the costs and benefits of differences in washing habits (Levi Strauss & Co., 2015).

Findings

The following findings have been discovered in the Novozymes A/S and Levi Strauss & Co. case studies.

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Novozymes process

Novozymes: the LCA analysis indicates that the new process which is called elemental process saves energy and water compared to the conventional process. The process temperature can be significantly decreased as well as the production time and several baths (production steps) have been avoided. Furthermore, the applied amounts of some chemicals are reduced. The environmental load like global warning and acidification as well as eutrophication is remarkably reduced (Nielsen & Nielsen, 2009).

Levi Strauss & Co. General Findings

The general findings, according to Levi Strauss & Co. (2015) address water consumption, climate change, energy consumption, and sustainability. Additionally, consumer use, materials and production, and other issues were included in the case study.

Water Consumption

Fiber production, predominantly cotton, contributes by a wide margin to water consumption. Expanded Scope: By expanding our scope to include the leading cotton-producing countries, we have seen the water consumption from cotton cultivation increase to 68% of the total impact.

Climate Change

Consumer care and fabric production are the most significant phases for climate change impact and energy.

Energy Consumption

Fiber production as well as consumer care influence the energy and water consumption, which in turn influences sustainability.

Sustainability

To handle the waste in a correct way has a big impact on sustainability. To prevent the waste by producing only disposable fabrics for following for example current trends. This provides change of attitude in consumption.

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Consumer use findings

One of the most outstanding findings was that the washing has a big impact on the environment. Washing every 10 times a product is worn instead of every 2 times reduces energy use, climate change impact, and water intake by up to 80%.

The way in which laundry is dried has also a remarkable impact on environment. Cold water and air dry is the most environmentally friendly way.

Materials, production and other findings

Fabric assembly, which includes yarn spinning, dyeing, weaving, and fabric finishing has notable contributions related to climate change impact and non-renewable energy consumption.

Life cycle stages that had minimal contribution to impact include: fabric transport, product transport, packaging, production wastes, distribution, retail, and end of life waste.

Discussion

LCA allows focusing on the most significant environmental impacts as sustainability programs and policies are developed and evaluated. LCA informs product decisions to reduce the environmental impact from design, materials, and manufacturing and supports engagement with external stakeholders to reduce the impact.

Comparative life-cycle analysis is often used to determine a better process or product to use. However, because of aspects like differing system boundaries, different statistical information, different product uses, etc., these studies can easily be swayed in favor of one product or process over another in one study and the opposite in another study based on varying parameters and different available data. There are guidelines to help reduce such conflicts in results but the method still provides a lot of room for the researcher to decide what is important, how the product is typically manufactured, and how it is typically used.

A criticism of LCA is that it attempts to eliminate monetary cost analysis, which is replacing the currency by which economic decisions are made with an energy currency. It has also been argued that energy efficiency is only one consideration in deciding which alternative process to employ. However, LCA does help companies become more familiar with environmental properties and improve their environmental system.

In recent years, the literature on LCA of energy technology has begun to reflect the interactions between the current electrical grid and future energy technology. Some papers have focused on energy life cycle, while others have focused on carbon dioxide (CO_2) and other greenhouse

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gases. The essential critique given by these sources is that when considering energy technology, the growing nature of the power grid must be taken into consideration. If this is not done, a given class of energy technology may emit more CO_2 over its lifetime than it mitigates.

Conclusions

LCA can create **new possibilities** for both existing entrepreneurs and for business and engineering students. LCA is a **competitive tool** for entrepreneurs to analyze both the environmental impact and even the cost burden and marketing issues to guide the decision-making. Start-up entrepreneurs in the LCA field can act as **consultants** for the whole business life to assist in understanding these environmental impacts. When focusing on LCA field **engineering students** could also concentrate on main subjects when selecting their curriculum alternatives.

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Designing a MOOC to foster critical thinking and its application in Business Education

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Abstract

This paper provides a didactical model for Massive Open Online Courses (MOOCs) to support the acquisition of 21st century skills such as critical thinking. For this purpose, the didactic triangle as a model of teaching and learning is extended to allow for the consideration of experts, resources, literacy and an all-encompassing learning space when designing digital learning settings. The "Dr. Internet" MOOC is presented as a case study for the proposed didactic model. Preliminary results from the evaluation of this MOOC indicated that the setting had met with reasonable acceptance from the participants. Based on these findings, we argue for a more extensive introduction of digital learning settings with an output-oriented approach to foster the acquisition of skills rather than simply knowledge.

Introduction

Due to digitalization, the topic of informal learning in digital contexts has become increasingly important. Skills required by 21st century learners are – among others – critical thinking, communication, collaboration and creativity (National Education Association, 2016). However, these learning processes necessitate not only a learner (student) and a specific subject matter (or skill) to be learned, but also a teacher (Meyer, 2012), acting as a coach and enabler of learning processes. To provide learners with informal digital learning settings, various forms of

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Massive Open Online Courses (MOOCs) have been developed, which can also act as an extension of the classroom and which can have the purpose to assist the learners in acquiring skills, rather than acting as a mere platform for distributing information. However, MOOCs often lack a profound didactical model. For example, Ayala, Dick, and Treadway (2014) analyze factors for online-course satisfaction in business education and concentrate on the influence of content, accreditation, learning style and technology – indicating an input-oriented view on teaching and learning and not considering the underlying didactical model of the MOOC.

The purpose of this paper is to provide a didactical model for teaching and learning in digital contexts based on the concept of the didactic triangle (e.g. Meyer, 2012) to foster 21st century skills such as critical thinking. For this purpose, the didactic triangle as a basic model of in-classroom processes is extended by the dimensions of resources, experts and literacy and the surrounding dimension of the learning space to emphasize the focus on the formation of students' skills. As a case study for this specific didactical model, the Massive Open Online Course (MOOC) "Dr. Internet" is introduced. The presented MOOC demonstrates the viability of integrating teachers, learners and external experts into a setting of informal learning. Investigations into current applications of MOOCs in the field of business education indicate high potential for this type of MOOC (Ayala et al., 2014; Clarke, 2013). Thus, the topic has received an increasing amount of attention within recent years, making MOOCs with the purpose of skill acquisition rather than information distribution a field of great significance for research in business education.

A model of teaching and learning in digital contexts

Teaching and learning in digital contexts requires an underlying didactical model – similar to basic models designed for in-classroom learning. This section addresses the following matters: How can didactic situations be modeled? In which formal and informal settings can learning take place? What is the result of these learning processes and which skills and competences are important for 21st century learners?

The didactic triangle as a model of in-classroom processes

When designing a teaching and learning setting, the modeling of basic in-classroom processes is vital. The didactic triangle (Meyer, 2012) is a simple model of a didactic situation, since it points out that all parties involved are interconnected and have to be considered when designing teaching and learning settings. The didactic triangle in Figure 1 shows that teacher, student and subject matter are equally important aspects of every didactic situation and that all three elements are in bilateral relation. In contrast to other illustrations of the didactic triangle (e.g. Riedl, 2004), Figure 1 contains no information about the kind of relationship between teacher, student and subject matter. For example, Riedl (2004) puts the subject matter on top of the triangle, as the subject matter is taught by the teacher and learned by the student.

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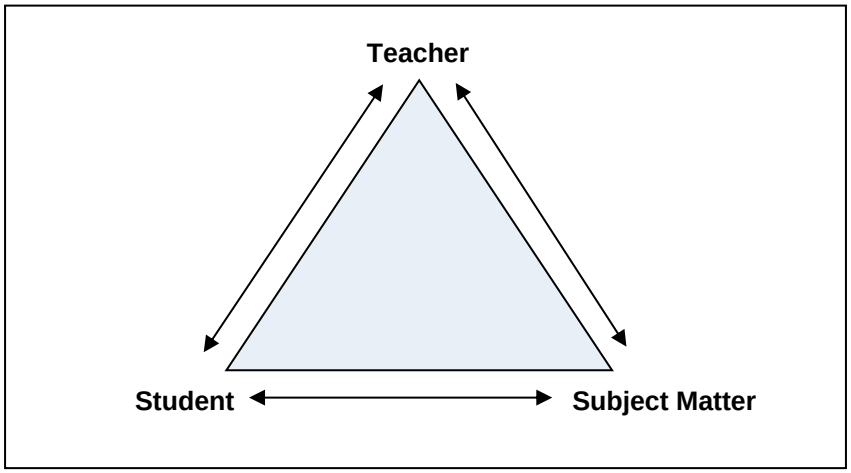

Figure 1. Didactic triangle. Adapted from Meyer (2012).

However, the simple model of the didactic triangle exhibits two limitations: (1) Processes of teaching and learning do not exclusively take place in the classroom. In addition to these formally recognized learning processes, there are informal learning processes that take place outside of the classroom, and for those the role of the teacher is of a different, more complex nature. (2) The didactic triangle might be a simplified model of an input-oriented teaching and learning setting. However, in the past decades, pedagogics has made a shift towards output-orientation, with the students' competences becoming the primary focus of teaching. This shift of teaching and learning settings towards output-orientation manifests itself in various forms, for example in competence orientation or the consideration of numerous literacy concepts. How to address these two limitations in designing modern teaching and learning settings is subject of the following elaborations.

Formal, non-formal and informal learning

The role of the teacher – despite being at the top of the didactic triangle in the illustration above – depends on the learning setting. Learning might take place as formal, non-formal or informal learning. *Formal learning* occurs in institutionalized learning environments (e.g. schools, universities) and leads to formally accredited degrees or diplomas. *Non-formal learning* does not lead to graduations, but includes a purposefully designed learning setting which might be supervised by a teacher (e.g. in the case of some MOOCs). In contrast to formal and non-formal learning, *informal learning* does not happen in institutionalized settings, but rather spontaneously, learner-led and without evaluation (Eshach, 2007).

Informal learning settings occur in countless contexts, e.g. a person might learn critical thinking by comparing articles in two different newspapers. Digital learning environments can be used to formalize such informal learning settings (Dabbagh & Kitsantas, 2012; McLoughlin & Lee, 2010). For this purpose, the didactic triangle might be used as a framework to intentionally model the teaching and learning setting. The idea behind the didactic design of the learning setting

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described within this paper is to take a common informal learning process and provide a practically tested model that can be used to convert an informal into a formal learning setting.

Concepts of literacy

Learning processes result in the formation of competences or literacies. Within this publication, we follow a broad understanding of the term literacy (United Nations Educational, Scientific and Cultural Organization, 2006). In the 21st century, the definition of being literate is closely tied to the proper handling of new media and modern information technologies. An information literate person "must be able to recognize when information is needed and can locate, evaluate, and use effectively the needed information" (American Library Association, 1989). Following this notion, Markauskaite (2006) describes various related forms of literacy in an extensive review: digital literacy, computer literacy, technological literacy, information literacy or – in broader terms – new literacies or 21st century skills.

21st century skills – the four Cs

21st century skills are important assets in a modern work environment. The National Education Association (2016) defines four key competences to be achieved by 21st century learners: critical thinking and problem solving, communication, collaboration as well as creativity and innovation. Primary driver for the significance of these *4Cs* are technological advances. First and foremost, 21st century learners must possess the ability to critically reflect upon information available via modern information and communication technologies. Since these technologies offer the potential to reach an ever-growing number of recipients, communication-skills are becoming increasingly important. Because of the greater complexity of modern work-environments, the ability to collaborate in multi-professional teams represents an essential skill. And since dynamic and constantly evolving computer technologies affect an increasing share of tasks in the learners' environment, creativity and innovation are also among the four main skills for 21st century learners.

21st century skills are closely linked to digital learning environments. A broad definition of digital competence, which outlines the concept "as the confident, critical and creative use of ICT" (Ferrari, 2013, p. 2), includes two of the four previously discussed elements. Critical thinking also represents a fundamental part of every business student's skill set (Claiborne, Desai, & Lindenberg, 2016).

Within this paper, an approach to foster critical thinking in a digital learning environment is developed. The purpose of this paper is *not* to diminish the importance of other – equally relevant – skills and competences, but to offer a model of how a digital learning environment can be designed in a way to stimulate critical thinking (a 21st century skill) of students in tertiary education. The model described in the following section addresses all three dimensions of the didactic triangle: teacher, student and subject matter.

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MOOCs as a learning environment

When George Siemens published his paper "Connectivism: A Learning Theory for the Digital Age" in 2004, he did not only describe a new learning theory but also a new learning environment based on actual societal requirements. He claimed that learning was a lifelong, continuing process, which is often related to informal learning processes: "Learning now occurs in a variety of ways – through communities of practice, personal networks, and through completion of work-related tasks" (Siemens, 2004). Formal learning settings can no longer accommodate all the skills needed by the learning individual, since modern working experiences are less predictable and predefined. People hardly ever stay in one professional field for their entire lifetime, but change fields of work or lines of business. Furthermore, technology plays an increasingly important role within the learning process, and with the rise of the Internet, the half-life period of facts in many areas is constantly shrinking (Arbesman, 2012; Siemens, 2004). It is impossible to know everything, consequently the "Know-how and know-what is being supplemented with know-where (the understanding of where to find knowledge needed)" (Siemens, 2004).

To keep pace with these societal developments, Siemens introduced a new learning theory, the connectivism, which is based on two main principles; namely that "[l]earning and knowledge rests in diversity of opinions" and that "[l]earning is a process of connecting specialized nodes or information sources" (Siemens, 2004). Two core skills derive from these principles, "[n]urturing and maintaining connections is needed to facilitate continual learning" and the "[a]bility to see connections between fields, ideas, and concepts is a core skill." The learners pace their learning per their own needs and (time) resources, and they decide in which specific fields of knowledge they wish to deepen their learning experience. Two things are especially important for a continuing learning experience: the learners' ability to learn on their own and their ability to tie and maintain nodes. These nodes comprise different resources, such as human beings, learning and teaching resources, teachers or experts in a field, libraries, online resources, and Web 2.0 tools, to name just a few of them. Consequently, the learning environment is highly customized, and the specific learning paths are not determined right from the outset, but evolve (individually) during the learning process.

In 2008, George Siemens and Stephen Downes designed a twelve-week course "Connectivism and Connective Knowledge" (CCK08) according to Siemens' connectivist learning theory, which marked the birth of a new course type, the cMOOC (i.e. the connectivist MOOC). The course program included guest speakers, live events and recommended literature as well as tasks for the students, but Siemens and Downes did not formulate specific learning objectives as predetermined learning paths. It was up to the 2.200 enrolled learners to decide which way to follow and which fields of knowledge to pursue. Consequently, there were no final exams and certificates but a learner-centered course where every individual learned on their own and in their specific pace.

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Three years later Sebastian Thrun opened his lecture hall at Stanford University to an interested audience. His lecture "Introduction to Artificial Intelligence (AI)" attracted 160,000 enrolled learners before the portal had to be closed. The so-called xMOOC was born, where the 'x' stands for 'extended' or 'extension'. The physical lecture hall is extended to the virtual learning space. The learners also could form learning groups and to connect virtually outside the course in social networks or even physically in real-life learning groups. In accordance with a weekly schedule, the course content is transported via video lectures and supplementary resources such as web links, documents, and articles. The learners usually have the possibility to interact in a forum. Their knowledge is tested at the end of each week in a quiz based mostly on multiple and single choice questions or in a peer reviewed feedback system. The learners do not know each other, but are encouraged to find ways to connect within and sometimes outside of the course.

Thus, cMOOCs and xMOOCs are two rather new learning environments that meet an important criterion set by Dillenbourg, Schneider, and Synteta (2002) more than one decade ago: "A virtual learning environment is a designed information space" (Dillenbourg et al., 2002, p. 3). It is not the virtual space itself that can be seen as a learning space, but only a virtual space that follows instructional design principles (Kopp & Lackner, 2014). A second claim concerns the social component, because a "virtual learning environment is a social space: educational interactions occur in the environment, turning spaces into places" (Dillenbourg et al., 2002, p. 3). The MOOC is a starting point that can help to form learning groups, whose interaction does not necessarily take place within the MOOC but in a place chosen by the learning group itself. A third claim dissolves the strict distinction between physical and virtual learning environment: "Most virtual environments overlap with physical environments" (Dillenbourg et al., 2002, p. 4). Virtual learning environments may also accompany traditional in-class learning settings. A fourth claim focuses on the learner's perspective: "Students are not only active, but also actors: they co-construct the virtual space" (Dillenbourg et al., 2002, p. 3). The learners themselves make contributions to the virtual learning spaces; the course instructors offer possibilities, and the learners decide on their own how, where, and when to learn.

The MOOC itself, whether xMOOC or cMOOC, is the starting and primary meeting point for the learners. Its instructional design is crucial for the learners' well-being and motivation (Kopp & Lackner, 2014). A poor didactic concept or a misled didactic design is one of the most important reasons for dropouts, as Colman (2013) has pointed out. Traditional models often focus on the in-classroom processes (Meyer, 2012) or draw a strict line between virtual and physical learning spaces (Dillenbourg et al., 2002). To better understand learning processes and experiences in MOOCs, traditional learning models must be adjusted, especially when the MOOC's primary aim is not to deliver factual knowledge but to build competences.

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Extending the didactic triangle to model digital learning environments

The traditional didactic triangle, as presented in Figure 1, focuses on the modeling of basic in-classroom processes which can be seen as one of its foremost limitations. Another limitation as mentioned above is its input-orientation, i.e. the focus on knowledge transfer instead of competence development. Its strength can be seen in highlighting the three main players in traditional learning settings and their interconnectedness.

Connectivist virtual learning environments benefit from an extension of this simple traditional setting. If we understand connectivism in the way Siemens (2004) described it, students not only *learn* the subject (content) *taught* by their teachers (Riedl, 2004), but they also learn from their fellow students. As Meyer (2012, p. 458) points out, it is not the student in the grammatical singular form, but the students that should be the teacher's target group. Meinert A. Meyer thus introduced two expansions of the traditional triangle: one of them is the focus on the students instead of the student, the second one is to add the society as a framework, since "[t]hree-quarters of what students learn is learned in informal settings at home in their family, in their peer group, with communication and information technology media" (p. 459). This point of view broadens the focus on in-classroom learning experiences to didactic perspectives on learning in general.

In the light of these insights, we would like to propose a different extension of the traditional didactic triangle: the addition of another triangle depicting other learning agents that are particularly relevant to digital learning environments. When it comes to MOOCs as a specific form of the traditional classroom, it is not only teachers and peer groups that students learn from, but also experts they may contact or meet in their course or their virtual learning space. Acting as a cornerstone for the additional triangle, it is the experts' experience and knowledge as well as their fellow students' experience that influences the learning process – not only on a factual basis, but also regarding the literacy gain. Literacy as the new triangle's second corner comprises the experiences and skills students already hold before the MOOC as well as the literacy they develop within the course. It is their prior knowledge and skill pool that shapes their ability to learn in a self-organized way and to find and evaluate information, to name just major two skills. A third corner can be identified in the resources used within and outside the course. MOOCs are mostly video-based, but there is supplementary Web 2.0 technology that enhances collaboration (e.g. forums, chats, messaging systems, social networks, collaborative writing tools), and often courses include web links that lead to the Internet as a learning resource, as well as reading recommendations. The teachers only make a preliminary selection from all the resources available in the virtual learning space and offer the learners a potential learning path. This selection plays an important role for the students' motivation to deepen their knowledge, as Colman (2013) has shown. The teachers' experience and competence to choose appropriate resources is critical; as is the students' literacy in finding supplementary resources that fit their own learning needs. The students tie nodes, they build up connections with their

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fellow students, with the subject matter, their teacher, and experts in the field as well as the resources used within and outside the course itself. In doing so, they expand their skills, e.g. methodological and social skills, but also those skills that have been identified as essential assets for 21st century learners, like communication, collaboration, and especially critical thinking.

These nodes in the triangles and their interactions are not only based in a physical environment, but also in the virtual space, which is the predominant setting in MOOCs. Hence, the traditional triangle should not only be extended by adding a second triangle comprising Resources, Experts and Literacy as important players, but also by including an all-encompassing dimension, which is the *Learning Space* that surrounds all six players as shown in Figure 2.

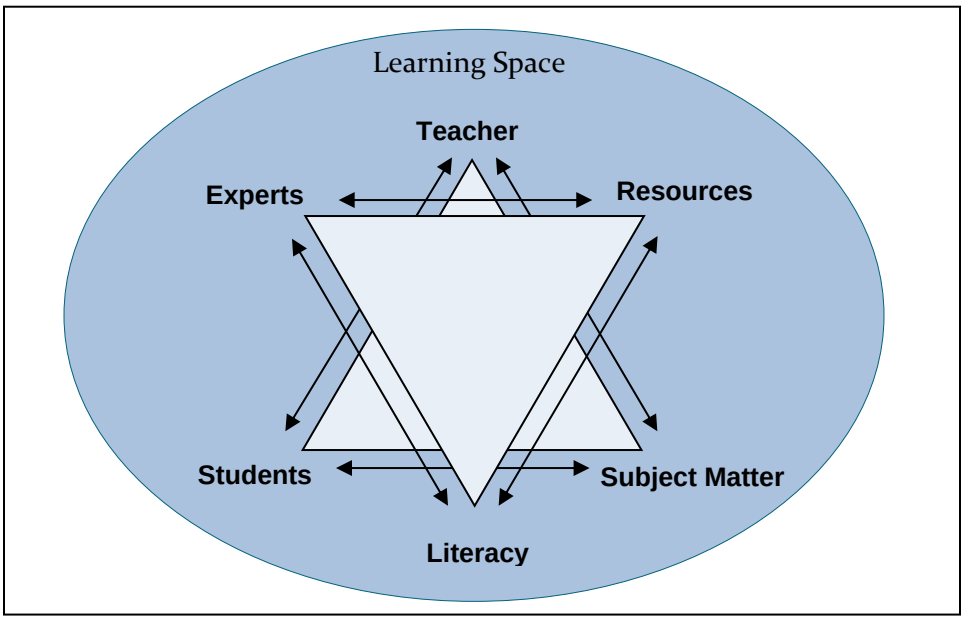

Figure 2. Extended didactic double triangle. Own representation based on the didactic triangle of Meyer (2012).

The learning space can be described as the virtual omnipresent space that cannot be seen as the Internet itself. Using the traditional triangle's diction, this learning space is a selection of possible nodes chosen by the teacher and the students, per the subject matter. It comprises supplementary resources as well as technology in a wide linguistic sense and describes the space teachers and students navigate in the process of learning. However, the most significant attribute of this learning space is the fact that students become teachers and teachers become students. Both might be experts regarding the subject (i.e. the input) but also regarding their literacy, especially in avant-garde MOOCs that have a more output-oriented view. Hanan Khalil and Martin Ebner (2013) point out that interaction in this context is not only meant as the

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interaction between teachers and students, as researched by Hone and El Said (2016), but also among students, as well as between students and the teaching and learning resources.

This extension promotes output-orientation and students' literacy as the primary focus of teaching, as well as the 21st century skills, the *4Cs*. In online learning environments, the learners learn to learn on their own but also in a collaborative way. They learn to communicate with each other and to find creative solutions to new problems in an increasingly digitalized world, with the informal, continuing learning process as a dominating and necessary guiding principle. They must critically analyze the value of resources and pieces of information found in the virtual learning environment, and of course they must know where and how to access information.

The "Dr. Internet" case study MOOC

This emphasis on new skill sets and their integration within the triangle setting of the main didactic agents (teacher, student and subject matter) are best illustrated with a case study where the concept of the extended didactic triangle was implemented as effectively as possible. "Dr. Internet" is the title of a specific xMOOC that was conceived and designed to accommodate the acquisition of 21st century skills in a moderated online learning environment.

Background

The Dr. Internet MOOC is part of an interdisciplinary research project on which three Austrian universities cooperated: the University of Graz, the Graz University of Technology, and the Medical University of Graz (Zimmermann, Kopp, & Ebner, 2016). The main research question concerns the way in which the Internet influences health literacy among the general population and how the increasingly common practice of online research for medical purposes affects the relationship between physicians and their patients.

As more medical knowledge becomes available online, this development bears obvious risks as well as great potential: On the one hand, the acquired medical information can be difficult to evaluate regarding its quality, and the correct application without any background knowledge can prove very challenging (Benigeri & Pluye, 2003). This might lead to under- or overestimations regarding the severity of physical symptoms as well as increased insecurity about a physician's diagnosis, or even the complete substitution of traditional medical treatment with health advice from sometimes questionable sources. Any of these problematic aspects could worsen the health outcomes of the patient (Robertson, Polonsky, & McQuilken, 2014). On the other hand, the internet provides unprecedented possibilities to democratize the access to medical information, a kind of privileged knowledge that is usually restricted to certain groups of health professionals. Combined with an increase in information literacy that matches the requirements of the ever-evolving online environment, this development could strongly improve the health literacy of the general population (Brodie et al., 2000). Subsequently, this might lead

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to more emancipated patients, better communication with doctors, a more efficient health care system and better health outcomes on a large scale. The ability for critical thinking is obviously one of the core components that will influence the manifestation of either benefits or drawbacks of online searches for medical information, and was therefore a key focus in the design of the Dr. Internet MOOC.

This MOOC is provided by the first and currently only Austrian MOOC platform named "iMooX" (www.imoox.at), which is hosted by the University of Graz and the Graz University of Technology (Ebner, Scerbakov, & Kopp, 2015). All course contents of the Dr. Internet MOOC were specifically created for this purpose and qualify as open educational resources licensed under a specific Creative Commons License. This means that the materials are freely available online even after the research project has come to an end, and that they can be used and modified by anybody, if this is not done for commercial purposes.

Didactic concept

Over the duration of six weeks, the participants of the Dr. Internet MOOC were presented with the task of assessing and diagnosing six medical case studies, all designed by an experienced general practitioner. The suggested standard procedure for the MOOC users was to watch the case study video (in which a patient would describe or exhibit various past and present symptoms in a sequence of scenes), followed by online research regarding the medical issues of said patient. Once the participants felt confident enough about their assessment of the situation, they were prompted to take a special quiz on the potential diagnoses for this case. In the subsequent week, another video regarding the case study was released, where the general practitioner was interviewed about the likelihood of the potential diagnoses he suggested. During these stages, the users were encouraged to discuss any related matters in the moderated forum of the MOOC. While the overall concept of this course is simple and straightforward, the individual components warrant a more in-depth inspection with regard to the underlying principles of the extended didactic triangle.

Special quiz format. To provide the participant with a tool to monitor knowledge gain and to track overall progress, most MOOCs include some form of tests or quizzes. Their successful completion is usually the main or in case of most xMOOCs the only criterion to receive certification of course completion, a model which reflects the traditional learning situation in the classroom. The most commonly used instruments for online testing are multiple choice questions, which are easy to navigate and allow for instant feedback on right or wrong answers directly after submission. However, they do not facilitate a more nuanced assessment of complex tasks, and while they can be adapted to various levels of difficulty, their potential to stimulate critical thinking is rather limited. Furthermore, some subject matters are not particularly well-suited for application in multiple choice settings. Diagnosing a patient based on symptoms alone appears to be one of them, and so the Dr. Internet MOOC incorporated a

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different kind of quiz format, where participants were asked to rate a set of eight potential diagnoses on a four-part scale ranging from "very likely" to "not likely". Since there was no "correct" rating that could be revealed as a solution to the quiz, other feedback was necessary so that participants could assess their own rating choices. After submission, it was possible for the users to compare their own ratings to the average results of all other participants who had already taken the quiz, therefore encouraging not only the scrutinizing of peer opinion, but also the origination process of collective results, since the quiz was continually updated and the peer results could drastically change depending on increasing numbers of completed quizzes. Additionally, there was also the option to compare one's own ratings with those of a group of physicians who were surveyed beforehand and who judged the likelihood of the suggested diagnoses based on the same case study videos (see Figure 3). This quiz format perhaps best exemplifies the integration of peer group as well as expert assessments in the evaluation of the individual learner's performance, which resulted from the user's information literacy and its application to resources of (online) information.

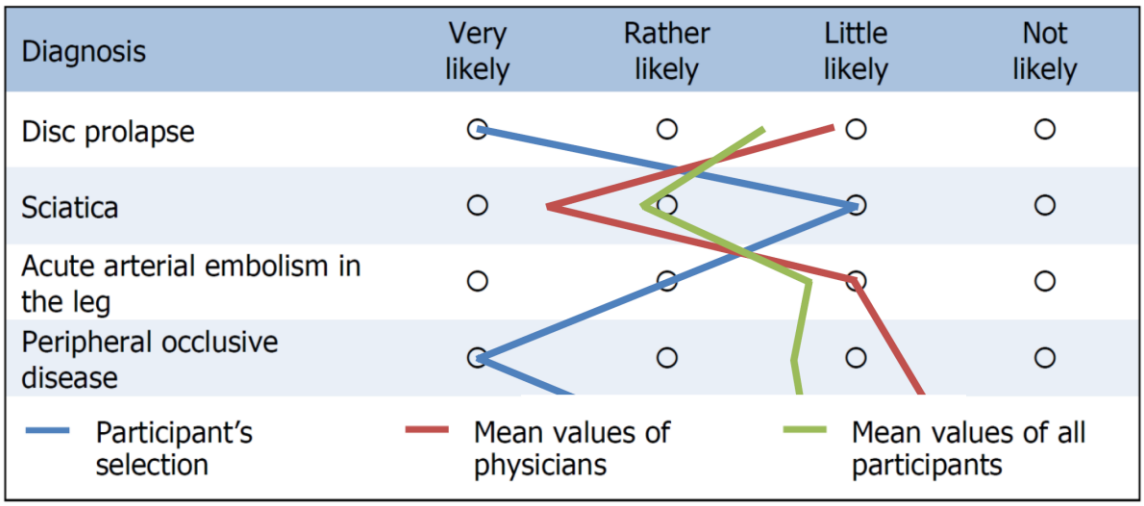

Figure 3. Results for four possible diagnoses of a medical case study.

Interview-style videos with an expert. In the resolution videos of the case studies, the general practitioner talks about the reasons for his own likelihood assessments of the suggested diagnoses, as well as giving advice on what to do in the event of noticing similar symptoms. It was a deliberate decision not to record these videos as a short lecture – while this format is well-suited to convey factual knowledge, it does not invite debate or questioning in the same way an interview does, which is commonly associated with conveying opinions. Even if the same matters are addressed, the expert in question will answer them in a different manner when talking to a large anonymous audience in comparison to having a somewhat ordinary conversation. Thus, the resolution videos for the case studies were important to incorporate both as a means of explaining the expert's opinion and providing additional information on the diagnoses, as well as to encourage the participants to revisit their own opinion-forming process

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(hence the release in the subsequent week) and perhaps to question the various resources they used to gain information. Additionally, they were also presented with an opportunity to question the expert's opinion, as it could happen that his favored diagnosis did not correspond with the most popular choice of his fellow physicians whose answers were part of the quiz. Thus, the interview-style videos further stimulated the critical appraisal of differing opinions and sources of information.

Moderated forum discussion. Most MOOCs include a forum as a tool of communication, to allow conversations among the participants as well as to enable interactions with the instructor(s). In the case of the Dr. Internet MOOC, the forum was monitored for 20 hours each day (between 6am and 2am), so that any queries would be answered and any violations of the forum rules would be dealt with quickly. In addition to a team of administrators there was one designated moderator who had a more involved role in debates, posting contributions to the ongoing threads and trying to instigate discussions by asking questions about the participants' own experiences. Perhaps due to the encouragement to share diagnosing ideas with the other users, the most popular threads were dedicated to the discussion of the medical case studies, where people debated not only their favored diagnoses, but also the ways in which they reached these conclusions. While the forum was seen mainly as a place for peer group exchange and informal learning cues, it was also used to establish a communication line with the expert. If the participants had questions about the medical case studies, the general practitioner (a persona well-known from the resolution videos) could be reached via a specific thread in the forum where he would post answers once a week. This high level of disposability and a social context in which to explore one's own or others' ideas appears to foster a more in-depth examination of course contents and therefore serves as another stimulus for reflection as well as a resource for new information, which again needs to be critically appraised.

Empirical results

The Dr. Internet MOOC was conducted twice so far (in November/December 2015 and May/June 2016) with a total of 474 registered users, of whom 278 participated actively. When looking at the activity data throughout the course duration, there is an obvious decline due to dropout that is often seen in MOOCs (Colman, 2013), and subsequently a seemingly low completion rate. Depending on whether this parameter is calculated based on registered or active learners, the Dr. Internet MOOC achieved a completion rate of 7% and 12% respectively, which is a somewhat adequate result compared to general experiences with MOOCs (Hollands & Tirthali, 2014). The activity data also displays a relatively gentle decline and no "mass exodus", which suggests that the contents and the didactical structure of the course were reasonably well received by the participants.

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Lessons learned: Potential applications in Business Education

The Dr. Internet MOOC provides a case study of how digital learning settings can be modeled to purposefully foster the development of 21st century skills such as critical thinking. Even though the content of this specific case study is oriented towards health literacy, the underlying didactical model might also be applied for the design of MOOCs in business education. After all, the ability to encourage critical thinking is a task of great significance for every business educator (Claiborne et al., 2016). Ayala et al. (2014), after evaluating a MOOC in business education, attest MOOCs a "significant place in education" (p. 237) – a claim that is also supported by Clarke (2013) after surveying the development of MOOCs in business education. However, since digital learning environments in general and MOOCs are still fairly young fields, more research is needed to evaluate specific theoretical models of online learning as well as practical strategies with regard to designing and implementing courses. Since one case study can hardly achieve more than an exemplary illustration of a certain approach, it would be beneficial to conduct research on a larger scale, like comparing several courses with higher student numbers. It seems likely that different disciplines have very distinctive needs when it comes to the development of new ways for integrating technological advances and existing disciplinary knowledge, especially when trying to foster 21st century skills, so the logical next step would be to design and study a specific MOOC tailored to suitable Business Education topics.

The adequate design and implementation of MOOCs is an issue likely to be concerning every business educator, since MOOCs have truly become a teaching and learning setting of great scope for the field of business education: Financial Times' *Mooc Tracker* currently lists 407 MOOCs with business or management-related content. 87% of all listed courses are hosted on the well-established platforms *Coursera*, *edX* and *FutureLearn*, with almost half of the listed business education MOOCs being hosted on *Coursera.* 375 out of the 407 courses include the possibility to obtain a certificate of achievement, though not necessarily a university qualification (Financial Times, 2016). However, this rise of digital learning settings does not imply the decline of business education on the tertiary level: A report published by the Association to Advance Collegiate Schools of Business (AACSB) shows that many MOOCs in business education is offered by institutions on the tertiary level (Nelson, 2015).

Two main challenges arise from the growing significance of MOOCs in business education: (1) The introduction of MOOCs includes the danger of dedicating too much attention to the development of students' professional competences (such as accounting or marketing skills), while neglecting other – equally important – competences, e.g. critical thinking. (2) Since many business education MOOCs addresses tertiary education students, the special requirements of a didactical setting for tertiary education students is a pressing issue.

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The first challenge (the danger of neglecting other competence dimensions beside professional competences) is addressed within this paper by providing a didactical model for a MOOC to foster critical thinking. Regarding the second challenge (the needs of the tertiary education student), dropout rates might be one of the first things to look at when establishing how well new digital teaching and learning settings are received by the students. Despite the significance of digital learning settings, the concept of MOOCs in general still struggles with issues of low completion rates (Clarke, 2013), which were also observed in the presented case study. However, since the evaluation data also suggest a positive influence of content and didactic structure on the participants' readiness to actively participate in the course, a more extensive application of MOOCs based on the discussed didactic model is suggested. Furthermore, evaluations carried out for previous implementations of digital learning settings might provide insight into additional possible measures for quality improvement in MOOCs. Stock and Winkelbauer (2012) evaluate a concept of a digital portfolio for students of a master's program of Business Education and Development. For their specific digital learning setting, they argue among other things for a "clear communication of the objectives" and "systematic integration […] within the curriculum" (p. 54). Both factors – clear communication of aims and integration in the curriculum – are also most likely to be key factors for introducing MOOCs to a wider range of applications in business education. With a focus on output-oriented rather than input-oriented didactical concepts as well as the enhancement of students' 21st century skills, well-designed MOOCs might further contribute to the advance of digital learning settings in business education.

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Learning competence: The ability to develop competences independently as success factor for employees

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Abstract

Continuous improvement are important for every company and hence also for employees. Depending on the field, being state of the art is an important issue (f.e. due to security reasons and regulations). In such cases, it is necessary that employees are proactive in training their competences and therefore ideally act independently. Not only regarding those sectors, continuous improvement is important, but also regarding personal development and career opportunities, the ability to learn and qualify one's self independently is a key factor.

This paper deals with the question of how learning competence could be defined and what advantages it entail for employers and employees. Therefore, a study was conducted, which shows the employee perspective on the topic. The results are furthermore compared to various other studies as well as current literature.

Introduction

The current technological development is mainly characterized by an increasing level of digitalization which affects nearly all life areas. New information and communication technologies are constantly entering the market, enabling close interaction between humans and machines as well as machines and products (Bauernhansl, 2014; Ramsauer, 2013; Kagermann, Wahlster & Helbig, 2013). Looking on the technical side, changes can be realized much faster and for that reason employers and employees also must be more flexible. Innovative working arrangements such as co-working spaces or remote working are replacing traditional full-time jobs and fixed job specifications (World Economic Forum, 2016). The importance of know-how is also increasing equivalently to the level of digitalization, which means that intellectual capital is gaining higher value within the company (de Vries, 2006; Stewart, 2003).

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Due to that development, employees are facing a broad adjustment of their job profiles: administrative work will decrease whereas networked tasks will increase (Spath et al., 2013; World Economic Forum, 2016). Consequently, the US Department of Labor in collaboration with its Bureau of Labor Statistics' Standard Classification of Occupations (SOC) developed the Occupational Information Network (O*NET). This taxonomy is based on highly valid statistical data and covers aspects such as typical activities performed on-the-job or recent physical working conditions (US Department of Labor).

Referring to the O*NET model, the World Economic Forum identified different core work-related skills that will characterize the requirements for employees through digitalization. Thus, a high level of problem-solving competence will be required as well as the ability to learn self-directed. This means employees are self-responsible for their learning process in order be able to adopt new content in a timely manner and to adapt it to individual situations. (World Economic Forum, 2016).

It is important to note that the World Economic Forum does not follow the current understanding of competences in the field of business education strictly. It rather represents a practical approach ant reflects the real need for the skills and abilities of industry. In this respect the present article focusses on the need of self-directed learning.

Problem and Purpose Statement

As pointed out future employees must show distinctive digital competences including communication skills as well as the ability to solve complex problems efficiently and evaluate the set measures (Botthof & Hartmann, 2015). The Future of Jobs report 2016 points out, that the outlined changes lead to a "shortening in the shelf-life of employees' existing skill sets" (World Economic Forum, 2016). This leads to the conclusion that continuous learning is necessary to ensure long-term success not only for the employee but also for the company. Therefore, the ability for self-directed learning is becoming more important (World Economic Forum, 2016; Botthof & Hartmann, 2015).

Research Question

The outlined purpose statement leads to following research question: How far and under what conditions are employees willing to accept the responsibility of self-directed learning? In this respect the topic of this paper is the employees' preference for independent learning and shows what requirements a company has to fulfill in order to support learning competence.

Review of the Literature

To answer the purpose statement, firstly a literature review was done to find a definition of learning competence that is suitable not only in theory but also for companies on the one hand.

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On the other hand, the literature review addresses the framework which is necessary for self-directed learning. This is the basis for the validation.

Definition of learning competence

There are various opinions about how learning competence is defined depending on the field of research (e.g. Czerwanski, Solzbacher & Vollstädt, 2005 for school learning). To avoid misunderstandings, this paper will describe characteristics of learning competence that are relevant for industry.

According to Reinmann and Mandl (2006), learning competence is based on the constructivist learning approach and consists of the elements shown in Figure 1.

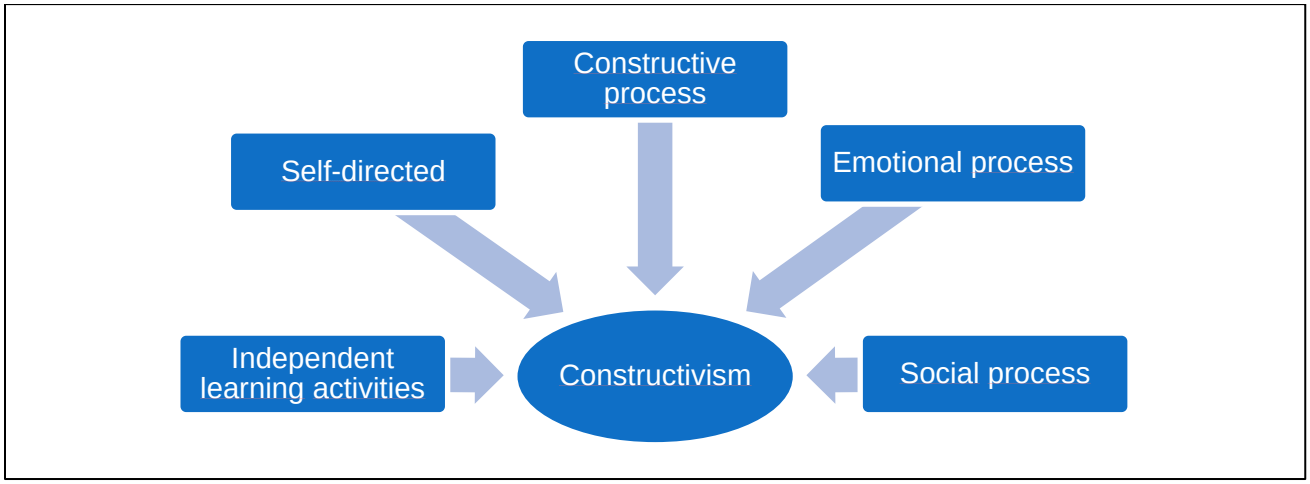

Figure 1: Elements of the constructivist learning approach (Reinmann and Mandl, 2006)

The outlined learning methodology relies on learning activities which are carried out independently in a predefined learning arrangement. For that purpose, the learning process takes place as a constructive process in which structures and links to the prior competences are developed.

Learning is an emotional process that challenges learners not only cognitively, but also emotionally and motivationally. Within the whole learning process social interaction is necessary to accomplish holistic and sustainable learning environments. Through interaction with others, a social phase of learning emerges and further learners are involved. This can also be named as social process (Reinmann & Mandl, 2006).

Self-directed learning

Based on the outlined definition of learning competence, advantages of having a high learning competence were analyzed. This was not only done for employees but also from the companies' point of view.

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Above all, the term self-directed learning itself stands for the ability to acquire competences that take place mainly by means one's own volition and responsibility (Volke-Groh & Martens, 2001). Thus, self-directed learning is a sub-discipline of employee qualification and is understood as an opportunity to learn with and from each other (Heidack, 2001).

Referring to the outlined requirements, being able to learn self-organized enables employees to develop their competences more quickly and on demand (World Economic Forum, 2016). The challenge for companies is how to create the appropriate framework to support these learning processes (Kienbaum, 2015; Stocker et al., 2014). The employee must feel capable of developing qualifications for their own work (Bünnagel, 2012). Once these are created, the employee can manage his/her further education through

- individual optimal time,
- individual choice of training method, and
- individual training scale (Bünnagel, 2012; Erpenbeck & Sauter, 2013; McKinsey & Company, 2015).

Implementing self-directed learning in companies implies several opportunities and risks.

Opportunities

Individual learning offers employees a high degree of individualization and flexibility hence training is adapted to the needs of the employees (Heidack, 2001). Furthermore, flexible learning sessions, so called just in time learning or on demand learning is possible (Volke-Groh & Martens, 2001). Targeted learning leads to an increase in effectiveness as learning becomes part of the daily workflow (Dehnbostel, 2008)

Beside that the high level of self-responsibility can have a positive effect on the motivation of employees (Bünnagel, 2012; Frey & Osterloh, 2002).

Self-directed learning is part of an innovative human resources development culture which not only changes the HR department but the whole company strategy to provide the outlined opportunities. Additionally, employees need to be aware that the company is not responsible for their personal training, but must support the employees and provide necessary framework (Robbins & Judge, 2013; Bünnagel, 2012).

The outlined changes also involve risks that should be considered.

Risks

It is important to say, that not every company is immediately ready to adapt its learning culture as there are not only organizational requirements (Robbins & Judge, 2013). Especially employees must be ready for the change, which means that the outlined learning culture depends on specific competences (Lotter & Wiendahl, 2012). Hence the main risk is that the

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employees are not able to learn in a self-directed way which leads to high physical pressure. Thus, it appears that employees develop either excessive or no demand on training. Employees must be supported in gaining self-management abilities to encourage employees to motivate and lead themselves and act independently (Bünnagel, 2012).

A second risk factor is related to acceptance. If the staff is not convinced of the new learning concept, the employees will not be able to implement and internalize it (Bünnagel, 2012). To promote acceptance, the management must support the new learning culture. Necessary resources must be made available and the employees must be supported in the introductory phase (Bullinger & Warnecke, 2003; Bünnagel, 2012).

Methodology

To answer the presented research question, firstly primary research takes place in form of a quantitative survey. Within secondary research the results are subjected to a validation process. There the results of the quantitative analysis are compared with current study results to determine the validity of the results.

The quantitative a survey was sent to 1,502 employees in Austria. The following criteria were relevant for the selection of the sample:

- Companies with more than 1,000 employees
- Locations throughout Austria
- Industry of technical services

The focus on all regions of Austria considers regional differences that could be occur. The restriction to the industry technical sales was therefore chosen because the legal regulations are very often changing in this sector, and employees are therefore particularly required to learn on an ongoing basis.

They employees were asked about their willingness to learn independently and under which conditions an optimal self-controlled learning process could be possible. In addition to the collection of demographic data, there were questions regarding further training in general and self-responsible learning specifically.

The survey was designed as a standardized questionnaire in paper form and covered both closed and open questions. With closed questions on the one hand demographic data were collected. On the other hand, areas such as the general willingness to learn, the attractiveness of incentives for self-directed learning or the quality of the previous learning arrangements were addressed. Open questions were directed primarily to the needs and attitudes regarding self-directed learning.

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The evaluation of the closed questions was based on frequencies as well as on cross tables. Using cross tables allows a combined frequency distribution of different factors asked in the questionnaire and allows conclusions to be drawn about the interaction of several factors. The answers given to open questions were subjected and summarized to core statements which were analysed.

Findings

The aim of the study was to gather opinions of employees regarding self-organized learning and to derive possibilities for the implementation of self-directed learning within the company. The survey showed that generally there is a great willingness for self-organized and independent training. In total 253 questionnaires were fully answered, which means a return rate of 16%. Nearly 80% of the participants pointed out, that they are open minded for self-directed learning. Furthermore, even every fourth employee stated that he/she is motivated for self-directed learning also during free-time if learning on demand during working hours is possible as well. Further training only during leisure time is no possibility for the employees.

The results show, that traditional learning in form of face-to-face lessons is still the mostly preferred training method for more than one third of the employees as shown in Figure 2.

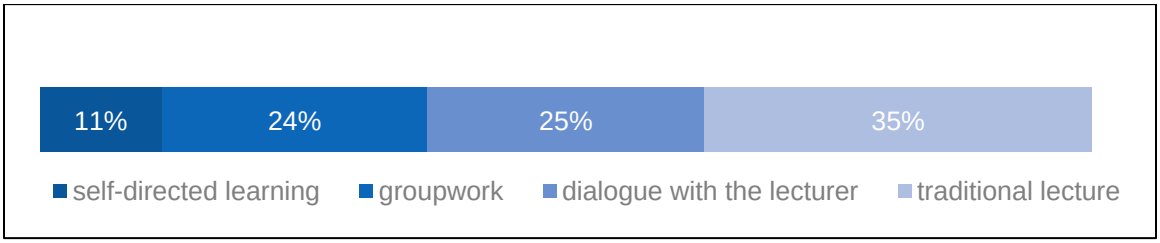

Figure 2: preferred learning methods

However, only about 10% of the employees said that they prefer self-directed learning. The big difference (80% are open minded but only 10% would prefer individual learning) can be explained by uncertainty. This result underlines the necessity of a holistic change process as well as the acceptance and support of the management.

Thus, the willingness is closely tied to the given framework conditions. Therefore, the following criteria are most frequently named by the employees asked:

- time for training within the working hours
- mobile digital devices are available
- training content is available unlimited
- training content is presented standardized

In addition, the employees stated that receiving qualification certificates would have a positive effect on self-organized learning.

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Summing up the named aspects are boundary conditions for a high willingness to independent learning.

Validation of the results

Comparing our results with current literature the following table shows similarities as well as new approaches. Therefore, the framework conditions are categorised and compared to relevant scientific literature (See Table 1).

Table 1
Comparison of study results with current literature

Category Result of our study	Source 1	Source 2
Time Within working hours	Digital learning must be supported (Kienbaum, 2015)	Integration of training in daily operations (Dehnbostel, 2008)
Hardware Mobile digital devices	Flexible workplaces incl. digital devices are installed (Kienbaum, 2015)	Mobile learning (Erpenbeck & Sauter, 2013; McKinsey & Company, 2015)
Availability Unlimited/at any time	Learning on demand (Erpenbeck & Sauter, 2013)	Cloud-based learning (McKinsey & Company, 2015)
Content presentation Standartized	Context relevant information (Stocker et al., 2014)	---
Certificate Necessary	---	---

It can be seen, that nearly all defined framework categories are confirmed by other recent studies done in this field. Mostly named and most important for the employees asked is the desire for training within the working hours. Regarding to that Kienbaum and Dehnbostel both provide digital embedded learning as solution. (Kienbaum, 2015; Dehnbostel, 2004).

There is also wide consensus (Kienbaum, 2015; Erpenbeck & Sauter, 2013; McKinsey & Company, 2015), that innovative learning methods such as self-directed learning requires adequate hardware in order to provide flexible work- and learning-places. This is directly linked to the need for on demand learning or unlimited availability of learning material.

Also, very important is user friendliness. Provided training content must be clearly structured as well as reduced to context relevant information as seen by Stocker, Brandl, Michalczuk,& Rosenberger (2014).

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The analysis of the data displays new criteria that cannot be found in the literature so far. The employees asked for not only certificates as motivational factor for learning, but pointed out that certificates are necessary to visualize their competences. This is a quite practical approach, which also depends on the industry of the company. This also might relate to the Austrian culture but would have to be analyzed in further research.

Conclusion and Recommendations

Living in an age of technical fast pace and digitalization it is important that employees realize that continuous improvement is necessary to be flexible and stay competitive. Therefore, self-directed learning is becoming a key competence. Employees must realize that further training is not a duty but a possibility for their personal success. Nevertheless, not only the acceptance for individual learning is necessary, but also the company must provide the required framework. The findings show that the main characteristics of a learning environment that facilitates self-directed learning. An embedded digital learning system must be provided that allows either on demand learning during working hours or flexible online training-modules.

Therefore, the implementation of a user-friendly Learning Management System (LMS) is recommended. Using a LMS allows companies to implement cross-organizational learning platforms that provide various learning content. The employees can define target-competences based on their individual training needs. Furthermore, the learning processes can be coordinated across the company by those responsible for human resources (Seufert 2001).

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