Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

Science and Math Courses in a Danish Digital Learning Platform – What Makes Them More or Less Popular?

Alysson Ramos Artuso[1], Stefan Ting Graf[2]

[1] Instituto Federal of Parana, Colombo, Brasil
[2] UC Viden, Fyn, Danmark

Abstract

As part of a Danish context of educational reforms since 2013, digital learning platforms (DLPs) are mandatory in primary and lower secondary education. Teacher-created courses are available in DLPs and can be shared, remixed, and reused by other teachers, providing a wide range of courses for systematic studies. In this article, we present an analysis of the Science and Math courses' popularity. Based on previous research and didactical theory, we focus on the question: Can didactical variables discriminate the most and least popular Science and Math courses in the learning platform Meebook? If so, which variables? The study was based on the random collection and coding of the 102 courses. Multivariate analysis techniques detected that eight variables can differentiate the course's popularity with a success classification rate of about 75%. Visual attractiveness, easy implementation, and students' work are the three aspects that teachers use to select courses. The study results have potential implications for platform designers, local and national authorities, as well as teachers who use the course builder daily.

Keywords: Digital teaching platforms, Primary school, Lower secondary school, Educational technologies

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

Digital Learning Platforms in Denmark

A digital learning platform (DLP) is a mixture between a kind of interactive digital environment and administrative tools aimed for, at least, students and teachers. It offers tools for classroom management to the teacher and provides tools for authoring and customizing content, that includes both curriculum and assessment. The core of the platforms is the course builder function.

In 2016, Denmark made the use of DLPs mandatory in all primary and lower secondary schools (K9). Since then, the two most popular DLPs are Meebook, present in 46% of the municipalities in 2018, and MinUddanelse, present in 43% (Fælles Mål på læringsplatforme, 2018).

The introduction of DLPs is part of digital initiatives that aims to (i) provide a common public infrastructure to users, (ii) support the learning process (including the acquisition of digital learning materials) and (iii) establish a set of common public standards for educational data exchange (Brugerportalinitiativet, 2014). The learning platform is expected to facilitate teaching and learning as well as professional collaboration by sharing course designs.

In both DLPs, Meebook and MinUddannelse, the course builder allows functions for teachers to plan, carry out, and evaluate teaching, as well as integrate teaching and learning materials, assess individual students' learning activities, and create students' self-assessments. Besides that, teachers can search and reuse courses designed by other teachers. As the template is digital, teachers leave digital traces of their practices and it is possible for researchers to get easy access to a wide range of course designs and study them. Unfortunately, only Meebook allowed the researchers to analyse its platform, while MinUddannelse did not allow any access. There is no financial or personal links between this study and the Meebook company.

Research on Digital Learning Platforms

As a recent issue in K9-school, there are not many digital learning platform studies in Denmark. Most of them were concerned about DLPs implementation. It is the case of the inspirational materials

about how to choose, implement and use learning platforms published by The Danish Evaluation Institute (Danmarks Evalueringsinstitut, 2016). It is also the case of the Common Goals on Learning Platforms workgroup (Fælles Mål på læringsplatforme, 2018) that made studies and recommendations on five topics, including the need for enhanced local dialogue on the meaningful use of DLPs and more experimental approaches to learning platforms.

A larger research and development project were carried out by a broad consortium of six universities, under the leadership of Aalborg Universitet. The project also intended to facilitate the implementation of learning platforms and generated six reports. The 6th one, the technical report, summarizes the results of two surveys – one for the educational staff and other for the students – during the implementation of DLPs in 15 schools geographically spread in Denmark. One of the conclusions was that there were limited opportunities for the platforms to enhance social aims, visible learning, and students' evaluation. In addition, the platforms were not used for teacher collaboration and dialogue on teaching. Nevertheless, the teachers reported that digital platforms facilitated course planning and year planning as well as the application of learning objectives (Kølsen & Qvortrup, 2017).

In an on-going research, Andreasen & Christiansen (2017) examined this new mandatory initiative in the Danish as part of a global tendency of innovation and effectiveness in education that leads to a transformation of the teachers work. They collected data in workshops with teachers and the preliminary results show that radical transformations have not yet materialized.

Tamborg (2019) found a different, but non-contradictory result in a study involving 16 schools across Denmark about the implementation of DLPs for the stakeholder in general and for mathematics teachers' work. The researcher detected that

> … digital platforms have implications for the core of mathematics teachers' pedagogical work. The implementation of digital platforms results in a complex interplay between teachers' pedagogical work and their usage of platforms. In particular, the platforms' integration of learning objectives has proven to be a central aspect of how teachers' use and experience using the platforms in their work. This thesis identifies how the platforms' integration of learning objectives in some cases may support teachers in making qualified decisions when planning and teaching lessons. In other cases, this feature of the platforms leads to the experience of being forced to work in constraining and

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

> rigid templates that are not able to encompass the complexities of teaching and learning mathematics.

Graf, Gissel & Slot (2018) also argue that the DLPs frame teachers' planning. In the study, they were concerned about the usage of learning objectives and their assessment, the use of the platform in relation to the intention of sharing teacher-created course designs and how teachers deal with the integration of multimodal learning materials in the course design. The authors collected the 102 most shared courses in Meebook and coded them based on didactical variables such as type and number of objectives, type of assessments, type of learning materials and activities. They identified an insufficient use of learning objectives and corresponding assessment and an increased, but didactically questionable, incorporation and creation of learning goals and assessment. They also detected a dominant use of receptive activities, as well as a lack of context-specific communication between teachers and students. According to the authors, the course builder serves rather as a residue, a repository, than a platform for active and productive learning.

In an international context, Pepin et al (2017) studied the digital curricula resources and learning materials (focused on digital textbooks) in mathematics education. Some of the founds was that there is a different affordance of digital resources as compared to traditional ones and "an apparent weakening of traditional demarcations between pedagogy and assessment, and between summative and formative assessment techniques, due to the nature and design of the automated learning systems" (p. 645). These aspects will be observed in this study too.

Another international study compared Brazilian and Danish digital learning platforms. The authors observed that the platforms are quite similar, but there are also some relevant differences in terms of collaboration, publisher's content use and relation to local public policies. In other words, there is a world tendency that shapes the DLPs, but the resources also consider pedagogical context (Artuso & Graf, (2019).

The Research Question and Methodology

On Meebook there is a "share it" option where teachers can search for other courses by grade level, subject, keywords, etc. If a teacher is interested in the course, he/she can share it, which means that a copy of the course will be available for edition and reuse. The most shared courses are the first results in the search tool.

Graf, Gissel & Slot (2018) studied the 102 most shared courses in Meebook on the premise that teachers had a good reason to reuse them. This research starts at this point: What differs between the most popular courses and the least popular ones to get the teachers' attention? Does the difference lie in the didactic aspects of the courses? We restrained the analysis only to Science and Mathematics courses. The reason is that the researcher's background is more appropriate to these subjects and, therefore, it was possible to deepen into the didactical aspects involved.

The research question is "Can didactical variables discriminate the most and least popular Science and Math courses in the learning platform Meebook? If so, which variables?" To answer that we collected and coded 102 Meebook courses in February 2019. At that moment, there were 725 Science and Math courses designed by teachers on the platform. Stratified random sampling selected the courses according to the department level and the subject. 50% of the sample was composed by the most popular courses and 50% by the least popular courses. Table 1 summarizes the sample.

Grade level	Physics/Chemistry		Biology		Nature/Technology		Mathematics		Total
	More popular	Less popular	More popular	Less popular	More popular	Less popular	More popular	Less popular	
7-9	9	9	9	9	0	0	10	10	56
4-6	0	0	0	0	7	7	7	7	28
0-3	0	0	0	0	4	4	5	5	18

Table 1 – Stratified sample amount

Popularity is measured by the number of times a course has been shared. If a teacher finds a course interesting, he/she can "share" it. After that, a copy is created and the course is available to be used and modified by the teacher. We define the "more popular category" for the first quartile of courses on the most shared list (top 25%). The "less popular" courses are the others 75%.

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

A limitation of this approach is that the course popularity can be influenced by other variables not listed. Other contextual factors can come into relation to explain the popularity of a course: such as the school organization, the importance of the courses in regard to others, the instrumentalization of the platform in the curricula, etc. Another limitation is that we are not looking for how the courses are been used in classroom (or even if they are been used), we focused just on the popularity given by the teachers.

We called didactical variables the directly measurable aspects related to how to teach and communicate knowledge to students. So, for instance, we are concerned about the number and type of learning goals and assessments, how large the courses are and whether they use games, experiments, etc. The set of variables was based on similar researches of Hansen & Gissel, (2017) and Graf, Gissel & Slot (2018) and initial expectations about what can influence the courses' popularity. Hansen & Gissel (2017) developed a theory on quality and Graf, Gissel & Slot (2018) use the concept of "Didaktik" in the German-continental tradition to draw on the didactical theory of learning materials. From the second study, we used the definitions and methodology that generates the following list of variables. So, the courses were coded in terms of the following primary variables:

- Grade level (0-3, 4-6 or 7-9)
- Subject (Physics/Chemistry, Mathematics, Biology or Nature/Technology)
- Anonymous course (yes or no)
- Number of chapters
- Number of learning goals (number of goals per phase and type)
- Presence of goals in pairs (yes or no)
- Types of assessments (cannot/can, don't know/know, don't understand/understand, didn't finish/finished, scale 1 to 5, no/yes, never/very often, bad/pretty good, don't recognize/recognize, must practice/are able to, or don't agree/agree)
- Types of learning materials (digital or analogue; didactic, semantic, functional, or subject specialized learning material)

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

- Elements of the learning's materials in the course (number of short texts, large texts, regular exercises, solved exercises, contextualized exercises, images, tables, maps, graphs, infographics, journalistic texts, videos, experiments, simulations, games, links and files)
- Elements of the learning's materials in the attached files (number of attached files, own materials, short texts, large texts, regular exercises, solved exercises, contextualized exercises, images, tables, maps, graphs, infographics, journalistic texts, videos, experiments, simulations, games, and links)
- Publishers' materials (yes or no)
- Web elements (presence of wiki document, embedded multimedia content, app/software, and files)
- Audience (teachers, students or both)
- Elaborated instructions (yes or no)
- Work with local needs (yes or no)
- Active learning methods (yes or no)
- Explicit work with students' preconception (yes or no)
- Contextualization (yes or no)
- Interdisciplinary work with other subjects (Physics/Chemistry, Biology, Nature/technology, Math, Geography, or Other)
- Types of examples (sports, daily life, nature, health/human body, technology, history, environment, and social issues)
- Activities organization (individual, parallel group activities, collaborative group activities, cooperative group activities)
- Types of activities (reception, simple productive or complex productive)
- Modalities of the activities (short written text, large written text, oral, picture, diagram, numeric, video, sound and body experience).

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

All of the variables have been coded as Boolean or numeric, allowing for an easy way to use statistical methods in order to identify which variables (if any) can differentiate between the most popular and least popular courses, as well as predicting the courses' popularity based on those variables. The statistical methods used for recognizing patterns were logistic regression and discriminant function analysis with cross-validation (Hair et al, 2010). They were implemented in Minitab 17.

Four courses were removed as outliers1 based on the principal component analysis, which improved the success rate of the discriminant techniques (Tabachnuck & Fidell, 2007). Two-sample t-test was used to verify differences between the most and least popular courses for each variable. Only the variables with a significant difference at the confidence level of 90% were used to the multivariate analysis. After the courses' overview, we will detail the variables excluded.

As an exploratory study, the reasons why variables are important or not to identify the popularity of courses are not thoroughly analyzed. The research aims to reveal a scenario, set up some initial explicative hypothesis and compare the results with other research. Studying the reasons deeply requires further investigation with a variety of methods, such as interviews and class observations.

Course Overview

In general, the Math or Science courses in Meebook were created by an anonymous teacher. The median course contains four chapters, with one text and one exercise per chapter. Images and attached materials are not so frequent, but they are present with one item each per chapter. Links are more often, but not so much: two per course. As a result, the courses are not so large or visually appealing and far from the potential of web interaction.

[1] The outliers differ significantly from other courses by one variable at least. For instance, one of the outliers has 187 exercises, while the average is 8.3 exercises per course.

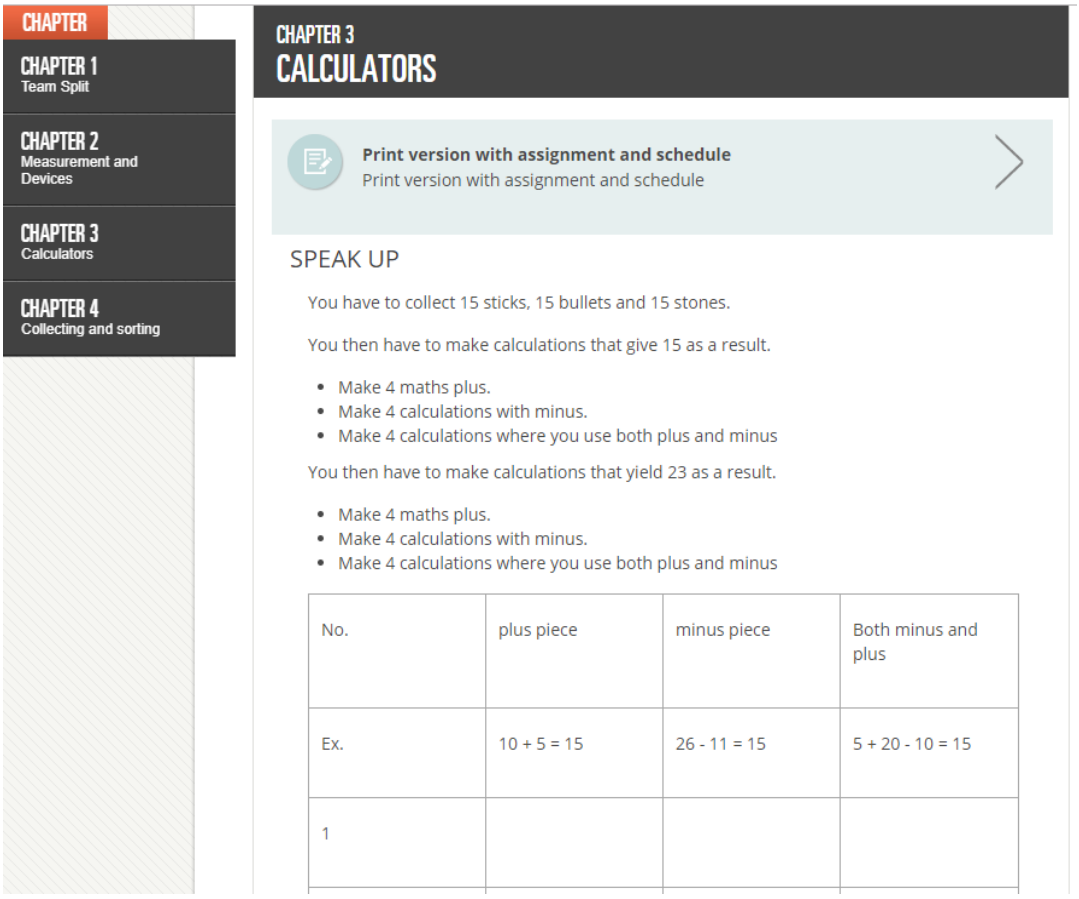


Figure 1: Chapter 3 of the course Mathematics in the forest for 2nd or 3rd grade. The English version was generated by Google Translator in order to keep the platform layout.

After some explanations, the students have to collect some sticks, pinecones[2] and stones to do calculations. Here we have a body experience activity (collecting items) and a numerical task. In general, the courses' exercises are diversified, with four different types of activities per course, but most of them are receptive activities with short texts, large texts or videos, or simple productive activities with short texts and calculations. More complex activities are not so common.

The average number of learning goals is four and the courses are based, in general, on examples from nature or daily life. Most of the links, images and attached materials come from publishers' textbooks or websites. Thus, digital or analogue didactic learning materials are predominant. Contextualization, elaborated instruction, work with students' preconception, interdisciplinary and active

[2] Bullets, in the translated figure, is a mistranslation.

learning methods are rare in the courses. This does not mean that they are absent from the classes, but only that the courses have not been designed to provide them. In an ongoing paper, these aspects will be deeper analyzed, but for now the focus is on the difference between the most and the least popular courses on the platform.

The number of short texts, images, attached materials or different types of materials can provide a first overview of eventual differences (they are not significantly different from subject or grade level). The graphs in Figure 2 compare the median of those variables by popularity. Visually, only the number of chapters, exercises, links and short texts appears to vary. However, when we plot the confidence interval (boxplots), they are overlapping. The two-sample t-test also indicates that there is no significant difference in these variables according to popularity. In other words, it is not so simple to extract a pattern from the data to discriminate the courses.

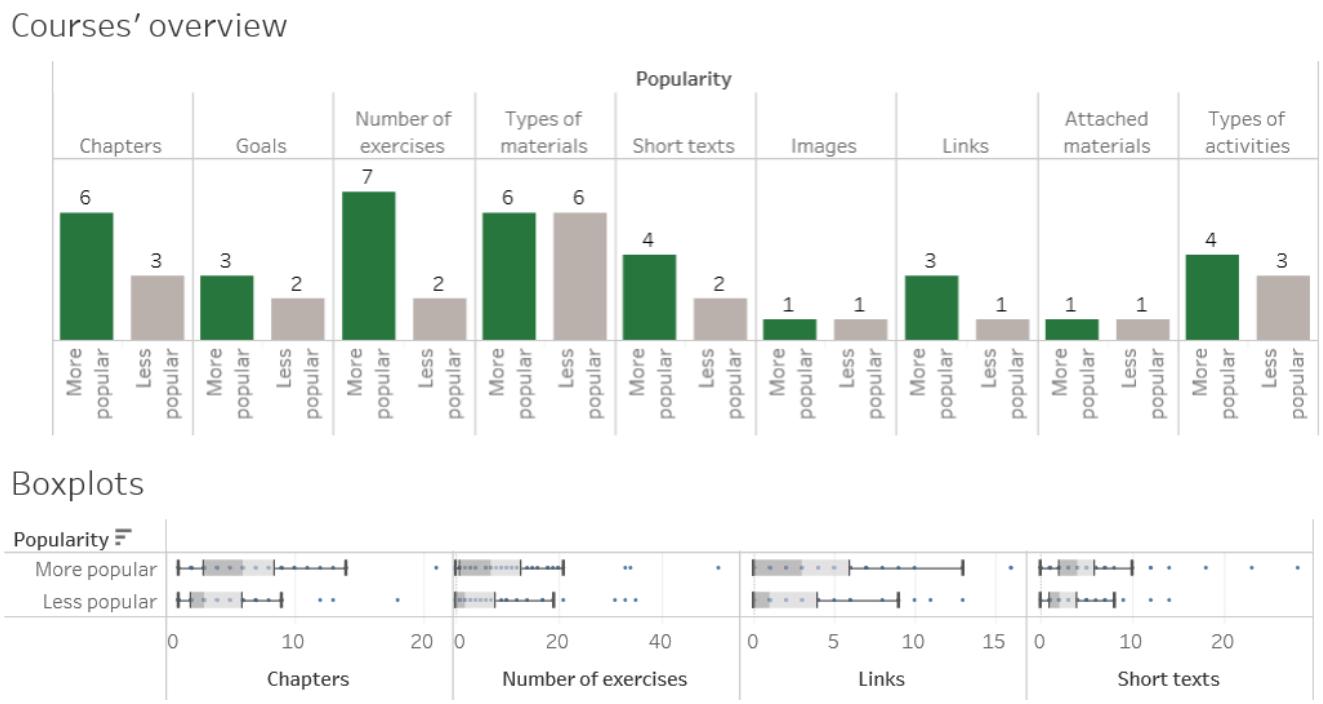


Figure 2: Comparison between more and less popular courses.

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

What Does Not Matter to Make a Course Popular?

Instead of asking directly what variables can differentiate the courses, one approach is to ask what variables are not relevant. There is pedagogical value in identifying and discussing the excluded variables, with some insights to think about the teachers' practices in a DLP. As we can see, most of the variables are useless to understand what makes a course popular in Meebook.

Didactic Scaffolding

Many scholars claim that didactic scaffolding is a key concept to think about pedagogical process and resources. Among many other authors, Greening (1998) and McKenzie (1999) use the term, that refers to the structures to support workers in a building, to refer to all forms of support learning. Clustering the variables of learning goals, elaborated instructions, interdisciplinary potential, local needs, contextualization, and active learning methods in a didactic scaffolding category, we can analyze the role of these variable to make (or not) a course popular.

Because of the platform affordance, the didactical scaffolding tends to start by the learning goals in Meebook (Graf, Gissel & Slot, 2018). In fact, some goals seem to be relevant, as we will see later. But five other elements that could be part of a didactic scaffolding – elaborated instructions, interdisciplinary potential, local needs, contextualization, and active learning methods – are not useful to explain the variance between the most and least popular courses.

By elaborated instructions, we mean courses with more instructions for students than just a verb to do a task. And not just in one topic or chapter, but in the most part of the course. If the process, the framing, the goals, the outcomes or the further steps are detailed, if the instructions help to make a didactic scaffolding for the students, then we coded the course as one with elaborated instructions. 18% of the courses have them and the proportion is the same between the most popular or least popular courses.

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

The category interdisciplinary potential was coded if any other curricular subject of the same grade level can be taught using the same course. For example, if the course was registered as Physics/chemistry, but at least one chapter (or another complete part, not just an example) of the course can be used in Biology classes. Again, 18% of the courses have interdisciplinary potential and this is not a game changer for their popularity.

Local needs category is for courses focused on the local context or needs. For example, if the course works with the environment impact of a local industry or the garbage recycling system of the municipality. In the sample, only seven courses are concerned about local needs (7%). As a hypothesis, the courses that work with local needs would be less popular because teachers cannot just transfer the same local context for another and, then, they would tend to do not share this kind of courses. However, the variable is irrelevant and the proportion (although it is very low) is quite the same in the two groups.

We defined contextualization as the link between the knowledge and its origin or application. More than a simple example, a contextualization should make clear to the students the answer for at least one of these questions: Why does this exist? What am I learning this for? What is the importance of this? When will I use this in my life? Commonly, the contextualization introduces the content and it is recovered during the course. The contextualization must cover a consistent amount of the course to the course has been scored in the category, which happened with 21 courses. A contextualization requires some effort to be planned and materialized in the learning material. Its potential to attract student's attention and give meaning for the learning makes us think that courses with contextualization would be more popular than without. This hypothesis was also refused, again there is no empirical evidence in our study that contextualization has any relevance to explain the variability of the course.

The same reasoning was behind active learning methods. In the category, we scored courses with instructional methods that require students to do meaningful learning activities, think about what they are doing and have opportunities to practice in unscripted, authentic settings, where stakeholders

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

(including the students themselves) invest in the outcome. Inquiry based-learn, Project-based learning, Problem-based learning, Flipped classroom, Experimental learning, Game-based learning, Team-based learning, Peer instruction are some of the active learning methods. However, the boundary among the definitions is not always clear and many common strategies can be used in an active learning method even without a rigorous framework. With more possibilities to students' engagement, we expected that courses with active learning methods would be more popular. The expectation did not meet, and the 18 courses scored in this category have the same distribution between the two groups of popularity.

Types of Learning Goal Assessments

At the research moment, Denmark had mandatory national learning objectives in the curriculum. There are objectives in each subject and grade level through competences and the corresponding pairs of knowledge learning goals and skill learning goals. Usually, knowledge learning goals are assessed by a "don't know/know" scale, and skill ones by "cannot/can", but teachers can also create their own learning goals with different assessments. Besides the two mentioned types of assessments, Meebook allows teachers nine other options: don't understand/understand, didn't finish/finished, scale 1 to 5, no/yes, never/very often, bad/pretty good, don't recognize/recognize, must practice/are able to, and don't agree/agree.

In Meebook, creating and integrating goals and assessment scales are easy and have a prominent place in the course builder. When you create a course, it is usually one of the first information you must fill in. Figure 3 shows an example of the course "Our stars, moon and planets" of Nature/technology subject for second-grade students. The two lasts goals are own goals. The type of assessment is in parentheses.

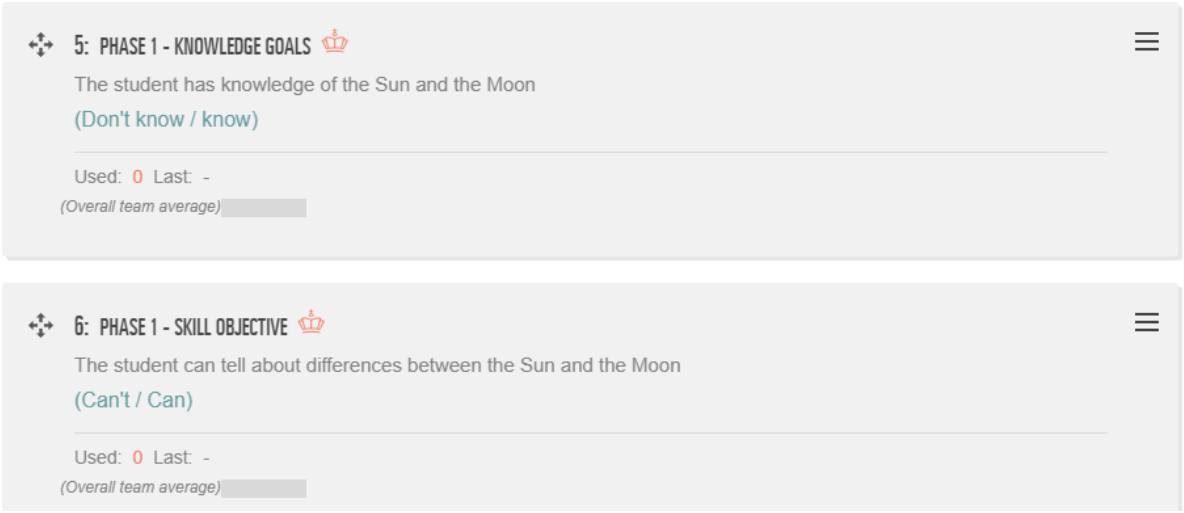


Figure 3: Example of learning objectives and corresponding assessments (between the parentheses). The English version was generated by Google Translator to keep the platform layout.

In Science and Math courses, in a total of 130 assessments, only 17 (13,1%) were not in "don't know/know" or in "cannot/can" scale. Graf, Gissel & Slot (2018) had also identified this behaviour in a previous study with a sample of all subjects. Even though teachers can choose any assessment scale while creating own goals, they create the same kind of assessment there are present in the common curriculum. It is a rare case in which the Meebook course builder's possibilities do not seem to frame teachers' practices. The lack of teachers' interest in the types of learning goals assessments is also reflected in the similarity of the most and least popular course: there is no consistent difference between the nine types of assessments in the courses popularity. Perhaps there is a gap between teachers' use of learning goals and the logic behind their assessments. Teachers may just rely on the common learning objectives or do not consider the assessments as an issue, what is an outcome aligned with a qualitative case-study conducted by the Danish Evaluation Institute (Danmarks Evalueringsinstitut, 2012) about the teachers' use of the common learning goals. The study concluded that teachers do not use the hierarchy of common objectives for the planning of specific courses and do not see them as a question of teaching quality.

Types of Learning Material

Learning materials can be, firstly, break down in digital and analogue. We considered as digital all materials created or formatted digitally. Therefore, a video created for digital spreading is a digital

material, but a traditional movie is an analogue material, even if it is available on YouTube. In the same line, a digitalized picture of a textbook page is still an analogue material. On the other hand, a text with links, embedded media or any kind of digital interaction was coded as digital learning material.

Almost all courses have digital learning materials (95%) and a half have analogue ones. Both cases do not interfere with the course popularity. The presence of publishers' materials – texts, exercises, or images – from textbooks or publishers' website is also irrelevant to identify what makes a course popular.

Besides digital and analogue, we also distinguished learning materials into four general types (Hansen, 2010; Hansen & Gissel, 2017):

- Didactic learning materials are those produced for instructional purposes. They have a built-in didactic that carries out a number of tasks in the teaching, including identifying academic goals, disseminating content and framing activities and tasks. Textbooks are the typical case of didactic learning material.
- Semantic learning materials are materials that have been produced for purposes other than teaching. A movie, a novel, or a newspaper article are examples. To use these for educational purposes, the teacher must have adapted them didactically.
- Functional learning materials are tools used to support processes in teaching for both the teacher and the students. A ruler or software for writing texts are examples. They were not developed for an educational purpose, so teachers also have to frame the use of these didactically.
- Subject specialized functional learning materials are technologies produced for education, but that does not have didactization per se. Virtual laboratories without built-in learning path/didactization and dynamic maths tools like GeoGebra, Scratch or Modellus are examples.

We have expected that teachers valued courses with a variety of types of learning materials because diversity allows a wide range of teaching possibilities and increase the chance of students'

engagement. Therefore, courses with more types of learning materials would be more popular. However, the results refuted the hypothesis. The variables are not useful to understand the data variability between the most and least popular courses.

Web Elements

DLPs can count with many web tools to make them more attractive and interactive. Integrated tools to highlight text, share topics in social media, a comment box, a forum space or integrated profiles and blogs are some examples. But none of these is implemented in Mebook and teachers do not use them even as a link.

The course builder facilitates the integration of a few digital options, such as Google Drive, OneDrive and SkoleTube. Consequently, only wiki documents – understood as online documents created collaboratively –, links for apps or software, attached files and embedded multimedia content was seen in the courses.

Embedded multimedia content means the inclusion of audio, video, simulation, etc as part of the platform. For instance, you can play the video without being directed outside the platform by a link. Excluding this case, no other web element was important to identify more or less popular courses.

It can indicate, on one hand, that teachers do not regard the attractive and interactive potential that web platforms have. On the other, the platform affordance does not facilitate the integration of web elements, so much so that several possibilities are absent. Files, wiki documents and apps/software are found only in links and maybe in the first view of the courses – when teachers are looking for an adequate course to reuse – they are not perceived as a differential, make them irrelevant to identify which kind of courses teachers share more or less.

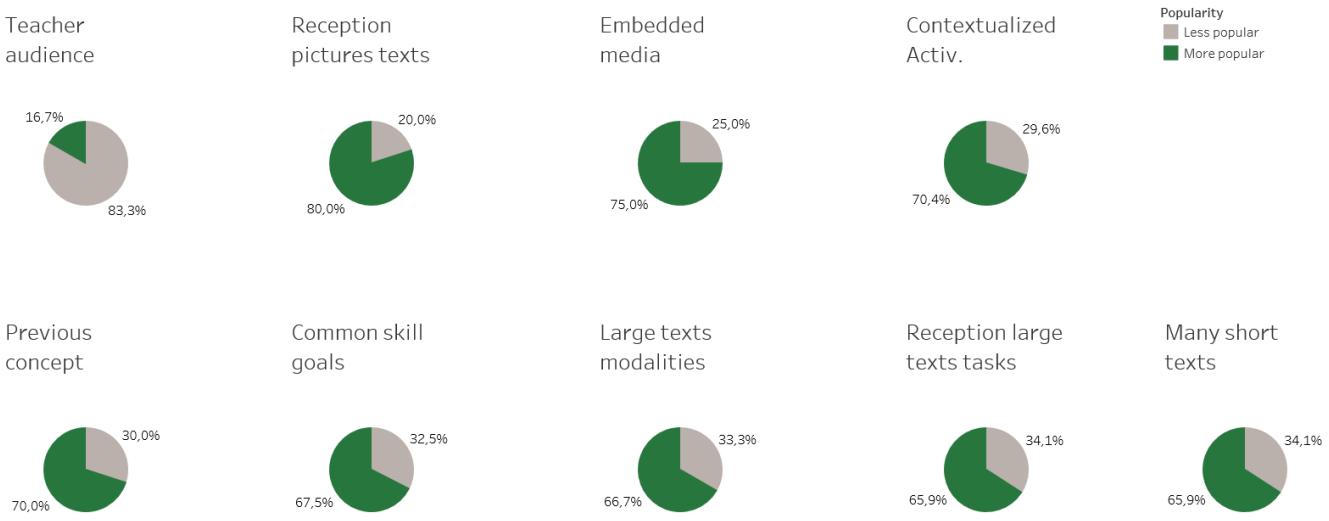
Elements of the Learning Material

Throughout the course, teachers can use many elements to compose the content. Texts, exercises, images, videos, tables, graphs, simulations, experiments, links, attached files, etc. As a hypothesis, we

thought that courses with many different materials and especially with visual appeal (many images or videos, for instance) would be more shared. The data shows that it is not true. A course with many different materials is not better valued and the number of images, tables, graphs, maps, infographics, journalistic texts, videos, experiments, simulations, games, and files are also irrelevant to identify the course popularity.

What Matters to Make a Course Popular?

After seeing which variables are not relevant at all, let us examine which ones can make a course more or less popular in Meebook. 19 variables are statistically different according to popularity. They are present in the Figure 4, but not all of them are part of mathematical models that identify and predict the popularity. In fact, only 8 of these 19 variables are enough to understand what makes the courses popular or not.



Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

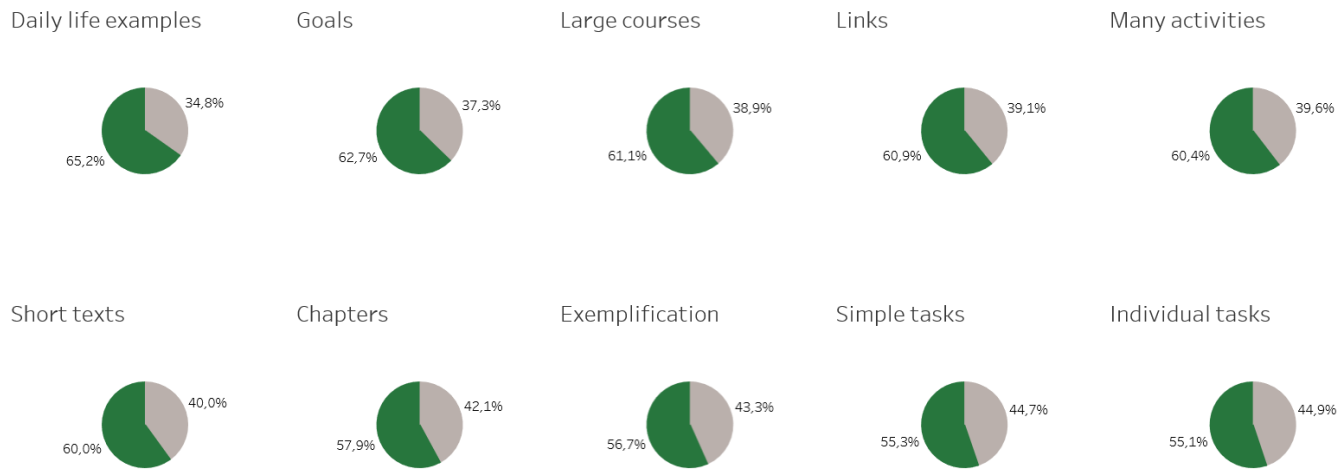


Figure 4: Variables with a significant difference according to the popularity.

Logistic regression and discriminant function analysis are multivariate techniques able to recognize patterns in data and give equations to identify or predict classifications. The models were run with cross-validation to provide more robust results and not results overfitted to the data.

Cross-validation takes N replicate samples of the data, taking N-1 of the data points to build the model and testing the results against the remaining single data point, in N systematic replicates. Thus, the data used to test the model was never used to build it, giving a lower success rate, but an unbiased model (Hair *et al*, 2010). With this technique, the success classification rate was 72.4% in logistic regression, using only six variables, and 76.5% in discriminant function analysis, using only seven variables.

Part of the variables is the same in both models as shown by the equations and graphs below. The next topics explain the meaning of the variables and discuss them.

The logistic regression model gives the equation

Popularity = exp(Y)/(1 + exp(Y))

Y = –1,604 + 2,348 * reception pictures + 2,068 * embedded media + 1,073 * more short texts than median + 0,790 * large text modality + 0,744 * number of common skills goals – 0,319 * total of goals

 https://doi.org/10.21344/iartem.v12i1.726

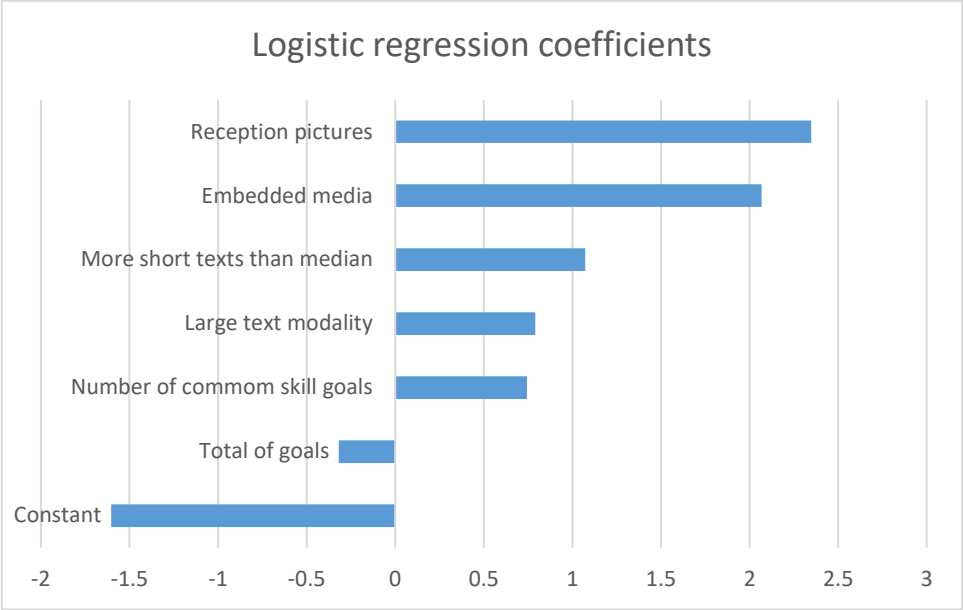


Figure 5: Logistic regression coefficients

The discriminant function analysis model gives the equation

Popularity = 0,207 + 0,421 reception pictures + 0,334 * embedded media + 0,183 * large text modality + 0,117 number of common skill goals + 0,089 individual tasks – 0,050 * total of goals – 0,190 * teacher as audience.

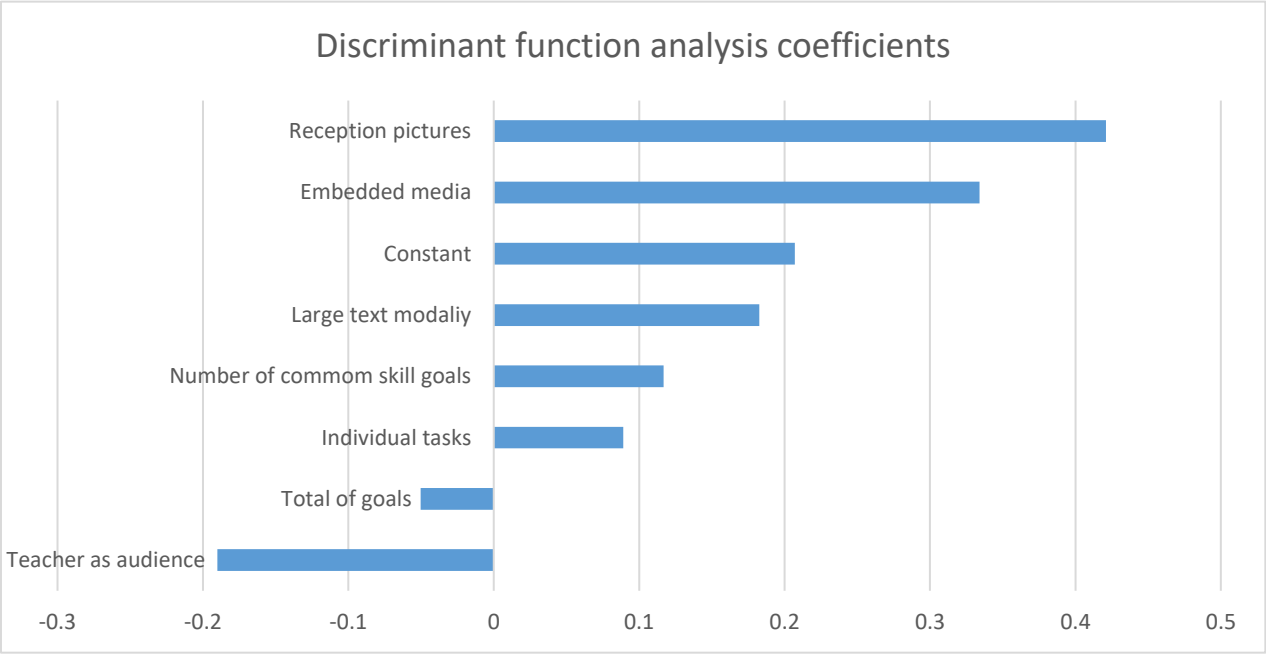


Figure 6: Discriminant function analysis coefficients

Activity Modalities – Pictures in Reception Activities and Large Texts

To code the activities, we initially divided them into three types, following the Graf, Gissel & Slot (2018) definitions:

- Reception acquisition activities: students are expected to read, see or hear something. For example, if they need to watch a YouTube video or read a text to do an activity. The relation between the activity and the text/video/image/etc can be explicit or implicit.
- Simple productive acquisition activities: students are expected to find answers to closed tasks or engage in skill training (e.g. fact-finding, control questions, multiple-choice procedures).
- Complex productive acquisition activities: students are meant to work with the content in a way that involves more than training. Complex productive tasks are open and require comprehensive investigation, finding solutions, or experimenting. It is often a product work where students construct knowledge. The knowledge that the students work with is not only given. Complex production means self-processing of something, finding solutions, testing experiments (not recipe-like). The question "why" can be used as a criterion.

Afterwards, we also scored the following activities modalities:

- Written language, short texts – Texts with less than ten lines
- Written language, large texts – Texts with ten lines or more
- Oral language – Oracy, talks, pronunciation
- Pictures – Photo, painting, drawing, icons
- Diagram – Graphs, diagrams, tables
- Numbers or Symbol – Calculations, symbols, math/chemistry notations or math demonstrations
- Video – Moving pictures
- Sound – Recorded sound, music, clear sound

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

- Body – Body experience means more than just see/observe, it includes the active use of more than one of the five senses and hands-on tasks (such as experiments, models, prototypes and mock-ups).

In 78% of the courses, teachers framed the receptive work for the students. In these cases, teachers mainly import semantic and/or didactic learning materials, such as texts, pictures and graphs. Often there is no additional instruction related to material or just a truly short instruction and no additional scaffolding, for example, "Read about insects". The scaffolding of the receptive work, such as taking notes, doing source critique, or identifying important issues, is missing.

“Reception picture” is a Boolean variable, coded just as 0 (absent in the course) and 1 (present in the course). The presence of pictures in reception activities tends to be the most relevant variable (reception pictures) in the two models used to identify patterns in the courses’ popularity, what can be seen by the highest coefficient in both equations. A course with reception picture tends to be more popular than a course without it.

80% of the courses with pictures in reception acquisition activities are in the most popular courses group. One possible reason is that images can easily catch attention when a teacher is looking for a course on the platform. Nevertheless, the number of images is not important, only their presence or not in reception activities.

Another result is the importance of activities – any kind of that, reception, simple or complex productive acquisition – with large text. The variable “large text modalities” computes the number of presences of large texts in the three different types of activities: reception, simple or complex. Therefore, a course that deals with large texts in two or three modalities has more chance to be popular than a course with large texts in just one modality.

According to Graf, Gissel & Slot (2018, p. 21), "even though digitally designed courses potentially could challenge the use of 'traditional' semiotic modes, the results demonstrate that written language still is the most foreground modality". The conclusion remains valid, but the reason why teachers value more when students have to read or write large texts than short texts is unclear. Perhaps, for the teachers, large texts indicate more complex tasks, with more pedagogical potential, but further research is needed to validate or refute this hypothesis.

Web Elements – Embedded Media is Relevant

Meebook platform allows embedding media from YouTube, Vimeo, SkoleTube and Google Drive. Teachers can add sounds and videos from these websites, but not other kinds of media, such as simulations or wiki documents, nor content from other websites. YouTube is the most common source of media; however, teachers prefer to link videos and sounds instead of embedded – this happened in 50% of the courses with media.

Visually the embedded media is more attractive than just a link and there is an advantage that student is not directed outside the platform while working with these tools. These can be reasons for courses with embedded media be more popular than courses without. 75% of the courses with embedded media are in the high popularity group. In both models, it is the second most relevant variable.

The Extension – Short Texts Matter

One preliminary hypothesis of the study was that larger courses would be more popular than short ones. With more content or more approach possibilities, other teachers would be more likely to reuse the course. Another argument for this hypothesis was the DLP as a time saver for teachers. By selecting larger courses, they would spend less time searching or creating different courses for each specific topic.

Six variables related to the course extension were removed from the models: larger courses, courses with more chapters, more large texts, or more exercises than the median as well as the number of

files and pages. It shows that most parts of the variables related to the extension are not responsible for the data variability. But one is important: the number of short texts.

By short texts, we mean texts with less than 10 lines in Meebook desktop template – around 700 characters – or texts in topics. Courses with more short texts than the median are widely shared, almost two-thirds of they are part of the most popular courses.

The language broken into small pieces resembles notes, but also the language of social media. In a different context, Artuso et al (2019) had also detected a preference for concise language in previous research with teachers on Brazilian textbooks. Here the learning materials are courses on DLPs and the country is Denmark, but the pattern remains the same. One reason may be precisely the influence of social media and the new style of journalism with short and direct texts that shape the teachers' consumption of texts. On the other hand, this preference may also be a result of the Meebook courses being more residuals than learning materials (Graf, Gissel & Slot, 2018). Under pressure, teachers have to use the platform and may not make much effort into the courses, but simply create them as a copy of their class notes or presentation slides. But here, what is striking is that the courses with short texts are the most shared. One thing is that teachers build courses with many short texts because they do not see pedagogical value in using DLPs or do not have enough working conditions to devote more time to plan and build the courses. Another thing is to choose deliberately already done courses with many short texts for reuse. In this case, the hypothesis of a transformation in the way we consume texts seems to be more consistent with the results.

There is one more complex issue related to this search for the reasons for the teachers' choices. It seems that when teachers have to read the entire course to choose one to reuse, they care only about the short texts. But when they are looking at the activities, they prefer courses in which students must deal with large texts, as seen before. In other words, teachers do not value large texts for themselves, but when students have to perform tasks with a large text, they consider it important. According to the logistic

regression model coefficients, large texts in activities are more important than the presence of many short texts in the course. In the discriminant function analysis model, many short texts are absent. The solution to the issue seems not to be an incoherent teacher behavior, but the acknowledgement of larger texts as pedagogically superior. Therefore, the preference for courses with many short texts is just part of a marginal step. A step that is taken when the first one has been already decided.

Learning Goals – Skill Goal is More Valued, a High Number of Goals is Not

Meebook affordance follows the current curriculum logic in Denmark and presents the common learning goals in a table and teachers can easily drag and drop the common objectives to the courses. This table has always a skill and knowledge objective as a pair structured in one, two or three phases that express the intended students´ progression.

In a report about teachers' understanding of learning goals and experience of learning goal-oriented teaching in Denmark, Carlsen, Hansen & Tamborg (2016) argued that teachers do not use the hierarchy of common goals for the planning of specific courses and prefer to deal with skill goals. This statement is coherent with the outcomes of our research because the number of skill learning goals is a relevant variable to identify the most shared courses, but only the common skill learning goals, not the created ones.

For example, a course with three common skill learning goals has the same chance to be popular than a course with one large text activity modality. Nevertheless, teachers negatively evaluate courses with many learning goals. Comparing the coefficients, three learning goals in a course make null the popularity tendency of one skill learning goal. In terms of goals, a popular course has many skill learning goals, but no others.

In average, courses have 4.7 learning goals and 2 of them are common skill goals, but the dispersion is high. One-third of the courses have no learning goals, while one-third has more than five. Two courses have 43 learning goals. Apparently, a high number of learning goals in a course points out a

lack of focus and seems pragmatically and didactically questionable. Graf, Gissel & Slot (2018, p. 9) found a similar result about the average and dispersion of learning goals and argues that "is quite astonishing when we from a pragmatic point of view consider the application of 5 or more objectives to one single course as a rather complex endeavor. We may ask whether it is reasonable or possible to pursuit and realize a high number of objectives in a single course.". The most shared courses suggest that teachers also have doubts about the applicability of courses with so many learning goals.

Activity organization – Individual Tasks

The organization of the activities was divided into four types:

- Individual activity: an activity that requires only one person to be done. If the student must only present or talk to people, it is still scored as an individual activity.
- Parallel group activity: activity in which students can do specific steps and just put them together later. If there is no information about the type of group activity, it was scored as parallel.
- Collaborative group activity: when students must discuss together and each one does separated steps, even if there is a final moment to share and discuss the results.
- Cooperative group activity: when all students must discuss and work together in all steps

About 10% of the courses have no activities and 44% have at least one kind of group activities. Besides group activities being common, individual tasks are even more usual: 80% of the courses have this kind of activity.

The variable is not part of the logistic regression model, it only composes the discriminant function analysis and its coefficient is the least important in the model. Thus, the presence of individual tasks in a course seems to be a necessary condition to be popular, but not sufficient, with a limited impact on the popularity.

One possibility is that teachers desire individual tasks in the courses because it is an opportunity for students to work online at home. Nevertheless, homework is not a widespread and frequent practice in Primary and Lower Secondary School in Denmark and an in-depth analysis of the activities is still pending. Further investigation should not only be able to shed light on the different kinds of activities but also include teachers' reasoning about these practices.

Teachers as the Audience

Besides the description, one indicator of the courses' audience is the hidden content. For each topic created in Meebook, the teacher can choose to make it visible for students or not. Creating hidden topics, teachers can communicate directly to other teachers embedded in courses aimed at students. It means that a course can have only students as the audience, only teachers or both.

The Boolean variable only teachers as the audience is the last relevant variable to differentiate popularity. Present in the discriminant function analysis model, it is as relevant as the "large text modalities" variable. Its coefficient is negative which means that a course that has only teachers as the audience has less chance to be popular. In fact, only 16,7% of the courses designed for teachers are popular.

It is expectable that the main purpose of teachers when they shared courses is to use them with students, so it is very plausible that courses for teachers are not popular. With these findings, we have consistent elements to answer the research question and understand better how looks like a popular course on Meebook platform.

"Sustainable Energy Supply?" — A Paradigmatic Course

The previous topic showed that didactic variables could explain the courses' popularity. However, a popular course is not just an unorganized joint of requirements, such as embedded media or too many short texts. To clarify how a popular course looks like, we have selected a paradigmatic case.

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

A paradigmatic case is a case that highlights more general characteristics of the object of study, such as a typical exemplar (Flyvbjerg, 2006). We selected it based on the variables mentioned above, looking for a course that meets almost every requirement to be popular.

The course “Sustainable energy supply” is a Physics/Chemistry course for the 9th-grade level. It encompasses embedded media, individual tasks, reception pictures activities, two modalities of large text activities (receptive and complex productive), many short texts, some common skill goals, few goals in total and not only teachers as the audience, but both teachers and students. It was the 14th most popular of 158 Physics/Chemistry courses for Low Secondary School (7-9 grade level).

The course has 11 chapters, one for each class, and a final chapter available only for teachers. Many chapters start with learning goals and assessments to students (like read a text, observe a picture or see a video) and then ask students to describe concepts in OneNote (Wiki documents). There is also questions, experiments, and group activities.

In the course description, the author describes it as an interdisciplinary course inspired by materials from the publishing companies ClioOnline and Xplore. It lists four learning goals, two skill and two knowledge ones, all common goals:

1. PHASE 1 KNOWLEDGE GOALS - The student has knowledge of energy conversions (Don't know / know)
2. PHASE 1 SKILL GOAL - The student can visualize energy conversions with simple models (Can't / Can)
3. PHASE 3 KNOWLEDGE GOALS - The student has knowledge of natural and man-made energy chains (Don't know / know)
4. PHASE 3 SKILL GOAL - The student can explain energy conversions with models (Can't / Can)

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

There appears to be a gap between the objectives of phase 1 and phase 3, but in fact the author reports more detailed goals in the chapters. These goals are not always explicitly related to common goals. Chapter 9, for example, is about generators and contains three expected learning goals: “you know how a generator is built; you understand how magnetism can be used to generate power; you can build a simple generator”.

The instructions are relatively elaborate, and the course has the Danish electric system as context. Except for the energy definition, scientific concepts are not explained in the platform. Links to ClioOnline and Xplore portals present the concepts or students must formulate them during the activities, mostly experiments. Chapter 12, the one available only for teachers, has guides to evaluate the students’ work and suggestions for new assignments.

Figures below exemplify how the course was designed. The layout is clean with lots of short texts and a link, picture, table, or video to make it look less boring. The content core is not in the platform, which is used more like a residual for students’ activities.

Figure 7: Group activity in a wiki document about energy working with the students' preconception. In the end, a link to ClioOnline content. The English version was generated by Google Translator to keep the platform layout.

 https://doi.org/10.21344/iartem.v12i1.726

Figure 8: Embedded video with activities in Chapter 4. The text to read in Chapter 5 as well as the activities are available in a link to ClioOnline portal. The English version was generated by Google Translator to keep the platform layout.

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

Research Limitations

The first limitation is that we look at courses in just one moment: February 2019. The authors may have changed the content over time and what made them popular (or not) in the past may not be the same content we observed in February 2019. The platform is also evolving and enabling new features and maybe some resources were not available in the past. However, this limitation is minimized by the fact that the courses observed still have similar characteristics to those studied by Graf, Gissel & Slot (2018) a year and a half earlier. It can indicate a bias in favor of older courses, that are more likely to be shared simply because they are available for a long time. Continuous systematic studies can detect whether courses with new resources are increasing their popularity or not. A related issue is that the number of courses grows rapidly. There were 725 Math and Science courses in February 2019 and 1055 at the end of August 2019, when a new scholar year has started. An increase of 46%.

Another limitation is that we investigate only the courses on the platform. We did not have access to the classes to see how the courses are conducted or to the teachers to interview them about their intentions when they reuse the courses. Our conclusions are based on visible outcomes extracted from the course builder, but one advantage is that we access a wide range of course and can study and systematically compare one hundred of them. Besides, the outcomes may reveal elements that remain hidden in teachers' speeches or practices, after wall, the choice process may not be completely conscious. The approaches can complement each other and further researches with class observations and teacher's interview can provide more pieces of evidence for understanding the uses of DLPs in the teaching and learning process.

Finally, the results are strongly associated with how data was coded. For example, the 10-line criterion for classifying text as short or large could be different and this could affect the results. Furthermore, it can be argued that for a student starting at school reading a 3-line text could be too long, while for one in 9th grade, a 15-line text would still be short. In any case, researchers need to determine parameters for their studies, even if they are not perfect for all cases and contexts. Therefore, there was

the concern to make these parameters explicit and the recommendation for further researches investigate the stability of the results found here.

Final Considerations

Didactical variables can discriminate the most and least popular Science and Math courses in Meebook. Mathematical models with a combination of eight variables can predict the courses' popularity with a success rate of about 75%. In summary, a popular course has common skill learning goals, but not so many goals in total, embedded media, lots of short texts, individual tasks, receptive activities with pictures, activities with large texts and not only teachers as the audience.

The results can be interpreted in three dimensions: visual attractiveness, easy implementation, and students' work.

Visual attractiveness encompasses embedded media, many short texts, and receptive activities with pictures. When teachers are looking for courses to reuse, the layout seems to be relevant. Pictures and embedded media – mostly videos – promote a variety of stimuli compared to large written texts. They also facilitate easy identification of content, allowing teachers to quickly assess their interest in the course. Visual attractiveness comes also from a fragmented language, intercalated with images, what is common in digital media. Apparently, this new language – the digital media language – works as a criterion for course selection. Thus, this found can have potential implications for platforms designers, for teachers who want to share their courses.

There are no variables that indicate teachers making more detailed searches, reading them carefully and valuing hidden aspects of the courses, such as the presence of complex productive activities, possibilities for interdisciplinary or active learning methods. Teachers may have believed in the promise of saving time used in DLPs advertising and are quickly looking for courses to use in the classroom, so the highlight for layout-related variables.

Volume 12 Number 1 https://doi.org/10.21344/iartem.v12i1.726

Easy implementation is also related to saving time promise. Carlsen, Hansen, & Tamborg (2016) and Graf, Gissel & Slot (2018) had also detected a teacher's propensity for skill learning goals because they are easier to deal according to teacher's opinion. Thus, courses with skill learning goals are highly valued, but not if there are many other goals together. Many goals may indicate a lack of focus and hard work to put it into practice. Teachers seem to be pragmatic in their choices, but we must be careful here to not simply take teachers as lazy people.

The introduction of DLPs in Denmark is part of a complex context. The DLP use is mandatory, which means that teachers have all the previous duties and more tasks, related to the creation and maintenance of the platforms, now. Labor conditions are changing and the transformations include working with new skills needed for the 21st century, new educational formats as a solution for a future labor market, demands of digital technologies use and the pursuit of accountability and ableness for the educational system to be able to demonstrate visible outcomes (Andreasen & Christiansen, 2017). Teachers can feel increasingly demanding, having to be online and work more and more – even outside of working hours – without having much choice or compensation for it. Pragmatic choices are perfectly coherent in this scenario.

The third aspect shows that not everything is reduced to try to save time, but there is a concern with at least one form of pedagogical work, which praises the students' tasks. Therefore, while courses are composed of short texts, teachers value activities that require students to read or write large texts. We must remember that the presence of individual tasks is also one variable used to discriminate the courses' popularity. Perhaps it is just a remnant of tradition, a hard-to-die old school habit in which individual textual production was the most valued and not a deliberated choice to oppose the stereotype of immediacy and superficiality of the content shared on digital media.

Although data were collected in Denmark, the validity of the results cannot be ruled out for other educational contexts. As mentioned, those concerning language are also present in the Brazilian context

and may be part of an on-going global movement of learning materials understanding. It has potential implications for platform designers, school leaders and teachers that daily use such course builders for teaching and the students' learning, but also for governmental authorities who set requirements for digital platforms used in public schools. Thinking about multimodality, mainly with short texts, images, and embedded videos, are aspects that go beyond the Danish case and can be contribute with the development of educational media around the world.

References Example

Andreasen, L. B. & Christiansen, R. B. (2017). *The transformation of teacher work through digital learning platforms*. Proceedings of Northeastern Educational Research Association Conference 2017.

Artuso, A. R., Martino, L. H., Costa, H. V., & Lima, L. (2019). The most valued characteristics of the physics textbooks according to Brazilian teachers. Revista Electrónica de Enseñanza de las Ciencias, 18(2).

Artuso, A. R.; Graf, S. T. (2019). Digital learning platforms and pedagogical context – a comparison between Brazil and Denmark.

Brugerportalinitiativet (2014). Undervisningsministeriet. Retrieved 08.08.2019 from https://www.stil.dk/-/media/filer/stil/pdf16/141015-aftaletekst-om-brugerportalinitiativet.pdf

Carlsen, D., Hansen, R., & Tamborg, A. L. (2016). Læreres forståelse af mål og oplevelse af målstyret undervisning. Retrieved 12.08.2019 from http://auuc.demonstrationsskoler.dk/forskningsprojekter/m%C3%A5ling-af-l%C3%A6ringsm%C3%A5l/rapporter-og-bilag/l%C3%A6reres-forst%C3%A5else-af-m%C3%A5l-og-oplevelse

Danmarks Evalueringsinstitut. (2012). Fælles Mål. En undersøgelse af lærernes brug af Fælles Mål Retrieved 16.08.2019 from https://www.eva.dk/sites/eva/files/2017-07/Faelles%20Mal%20rapport_web%20pub%20%282%29.pdf

Danmarks Evalueringsinstitut. (2016). *Implementering af digitale læringsplatforme – de første erfaringer*. Retrieved 08.08.2019 from https://www.eva.dk/grundskole/implementering-digitale-laeringsplatforme-foerste-erfaringer

Fælles Mål på læringsplatforme. (2018). Undervisningsministeriet. Retrieved 08.08.2019 from https://www.uvm.dk/-/media/filer/uvm/udd/folke/pdf18/jun/180620-fm-laeringsplatforme-anbefalinger.pdf?la=da

Flyvbjerg, B. (2006). Five Misunderstandings about Case-Study Research. Qualitative Inquiry, 12(2), 219-245.

Hansen, T. I. (2010). It og medier i et læremiddelperspektiv. KvaN, 30(86): 105-116.

Hansen, T. I. & Gissel, S. T. (2017). Quality of learning materials. *IARTEM e-Journal*, 9(1), 122-141.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2010). Multivariate data analysis. 7th ed. Pearson.

Kølsen, C., & Qvortrup, A. (2017). *Delrapport 6: Teknisk rapport om survey-data*. Retrieved 08.08.2018, http://www.emu.dk/modul/delrapport-6-teknisk-rapport-med-data-om-brug-af-l%C3%A6ringsplatforme

Graf, S. T.; Gissel, S. T.; Slot, M. F. (2018). Course designs in Meebook's course builder – analysis of 102 course designs. *Journal of Learning and Media*,, 11(18), 1-29.

Greening, T. (1998). Scaffolding for Success in Problem-Based Learning. *Medical Education Online*, 3(1), 4297.

McKenzie, J. (1999). Scaffolding for success. *The Educational*

Technology Journal, 9-4. Retrieved 16 jul. 2020, http://fno.org/dec99/scaffold.html

Pepin, B., Choppin, J., Ruthven, K., & Sinclair, N. (2017). Digital curriculum resources in mathematics education : Foundations for change. *ZDM Mathematics Education*, 49(5), 645-661.

Tabachnuck , B.; Fidell, L. *Using multivariate analysis*. Needham Heights: Allyn & Bacon, 2007.

Tamborg, A. L. (2019). *Organizational and Pedagogical Implications of Implementing Digital Learning Platforms in Danish Compulsory Schools*. Aalborg Universitetsforlag. Aalborg Universitet. Det Humanistiske Fakultet. Ph.D.-Serien