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Influence of Media Formats on Student Perception and Performance in Web-based Teaching

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ABSTRACT

The goal of this research is to examine the impact of media formats used in web-based courses on the way students perceive these courses and on their performance in the courses (in terms of grades). Factors influencing the evaluation of web-based courses by the students are analyzed, based on courses of an online distance-learning graduate program. In particular, we studied conventional hypertext-based courses, video-based courses and audio-based courses, seeking to find out whether the media format has an effect on how students assess courses and how good or bad their grades are. Statistical analyses were performed to answer several research questions related to the topic and to properly evaluate the factors influencing student evaluation.

Keywords

Web-based teaching, distance education, video-based course, audio-based course, student performance, student satisfaction, course evaluation, perceived learning outcomes, learning effectiveness

INTRODUCTION

Background and Motivation

Online courses and material supporting such courses are being delivered and presented to the learner in a number of formats today. Discussions about the influence of specific media formats on CBT (computer-based training) can be traced back to the late 1980s when a number of studies exploring the new horizons of computer-enabled learning were published (e.g. Hannafin and Rieber, 1989).

Technological advances and the growth of computer networks brought about new forms of CBT in the context of distance education. In 1996, a famous discussion between V. Carter and her counterparts R.E. Clark and R.B. Kozma triggered interest in the influence of media formats and their importance for e-learning (Carter, 1996). Recent studies dealing with the topic include the works of E. Wiebe and L. Annetta (2008), S. Park and J. Lim (2007) and E. Engh et al. (2007). However, after a decade of research there is still no definitive answer to the question of what is the best way to deliver and present learning material in CBT.

In the absence of crisp guidelines, creators of courses and study materials usually choose a delivery format based on their personal preferences, on what is "common", or on what they feel is the best choice for the particular topic under consideration.

Nowadays, a common format for web-based teaching is hypertext, i.e. study material presented in the form of HTML pages on the web, whereas more advanced approaches include continuous media such as videos and sound. Advocates of video technology claim that this technology is beneficial to the student's study experience because it is more lively than static text and thus more interesting for the learners (Kurbel, 2003).

Media Formats

The basis of this research are media formats that have been employed in a graduate distance-learning program offered exclusively over the Internet for several years. The courses included in the evaluation cover topics from the field of business informatics and computer science, such as information systems (IS), electronic commerce, computer networks, programming and IS development. The courses were initially created in 2001/2002 and have since then been taught every year. Although the courses were updated from time to time to reflect new developments, there were no significant changes regarding the course content, structure or media format. Therefore we were able to treat courses in successive years as a homogeneous group.

All courses employ web-supported teaching modes and electronic media for interaction between students and lecturers (e.g. discussion forum, chat room, e-mail). Table 1 shows the media categories and the courses belonging to these categories. Media formats are the following:

Type 1: Video-based course – In terms of content delivery, video-based courses are similar to a conventional face-to-face lecture in a brick-and-mortar university. Recorded lectures are provided in a video streaming format, together with synchronized presentation materials such as PowerPoint slides and online screen recordings. Unlike in a face-to-face lecture, students may watch all or parts of the lecture multiple times.

Type 2: Hypertext-based course – As in conventional distance education, the main content delivery format is text which the student studies. However, all material is provided electronically and can be viewed with a browser. The hyperlink structure of the text allows the student to proceed on non-linear paths through the lecture material.

Type 3: Audio-based course – This type is similar to type 1. As in a traditional classroom course where the lecturer uses transparencies for illustration, a sequence of slides (e.g. PowerPoint slides) synchronized with an audio track is provided in a streaming format or for download. Students view the slides and listen to the lecturer speaking.

Type 4: Audio and text-based course – As in audio-based courses, slides and an audio track are provided, plus a text transcription. All or essential parts of the spoken lecture are displayed as written text, along with the audio track. In this way, students can read the content while (or instead of) listening to it.

The courses examined in this paper are listed in table 1. It is important to note that the contents of all the courses underlying our research are derived from, and could also be offered in a classical face-to-face lecture setting. The media format for a particular course was not chosen on the premises of its contents, but rather based on practical considerations such as the authors' preferences, available resources and expertise in creating online course content. Each course in table 1 could have been offered in any other media format as well. None had specific contents that asked for a particular media representation.

| Category | Course Title |
|--|---|
| Type 1: Video-based course | Computer networks and Internet technology Introduction to programming Java programming Management information systems |
| Type 2: Hypertext-based course | Website engineering fundamentals Advanced website engineering Data management Enterprise resource planning and beyond Information management Information security Information systems architectures Management and organization of IT departments Software engineering management |
| Type 3: Audio-based course | E-Commerce and e-business networking Distributed business information systems Information systems development |
| Type 4: Audio and text-based course | Introduction to computer science Business intelligence Knowledge management Process modeling |

Table 1. Media formats and courses

Research Questions

The primary goal of this paper is to analyze the influence of media formats a) on the perception and the way students evaluate distance-learning courses using web technology (web-based learning) and b) on the performance of students (in terms of grades). We examine if differences in the students' evaluation of various course types and in their performance are statistically significant.

This paper addresses some of the issues lacking in previous researches as mentioned above. In particular, the focus of our investigation is on the following questions:

1. Does the media format (i.e. the way course content is delivered and presented) have an influence on the assessment of a course by the student?
2. Does the media format influence student performance (in terms of grades achieved)?
3. Does more "dynamic" course content receive better evaluations than static course content? (In particular, video-based courses vs. hypertext-based courses.)
4. Does text, in addition to multimedia, enhance the utility of the material for the student? (In particular, transcripts added to audio content.)
5. Does the evaluation of a course by the student depend on the difficulty of the course?

DATA AND STATISTICAL TOOLS USED

Data Sample

Students of the above mentioned master's program evaluate their courses each semester with the help of a questionnaire. One dataset was generated from student feedback collected at the end of each semester between winter semester 2001/2002 and winter semester 2007/2008 (called EVAL dataset). The part of the questionnaire that was used for this investigation is outlined in table 2.

| Survey Questions | | Question Type |
|--|---|----------------------------|
| How do you rate the following? ¹⁾ | Readability of course material (e.g. slides, text) | Likert scale |
| | Time required to access multimedia material | Likert scale |
| | Quality of videos (if applicable) | Likert scale |
| | Quality of sound (if applicable) | Likert scale |
| | Navigation in the course's website | Likert scale |
| | The specific multimedia format used for the course (i.e. video-slides combination, hypertext documents, slides with/without sound, etc.) | Likert scale |
| | Overall design of the course | Likert scale |
| Overall evaluation | Please give a grade for the course (A = excellent, B = very good, C = good, D = satisfactory, E = sufficient, F = fail) | Ordinal scale |
| | Did you have a language problem in understanding course material? | Likert scale ²⁾ |
| | How many hours per week, on average, did you spend on this course (including lectures, studying literature, preparing solutions for exercises, etc.)? | Open-end question |
| | How difficult was the course? | Likert scale ³⁾ |

1) Likert scale (1 - very poor, 5 - excellent)

2) Likert scale (1 - severe problem, 5 - not problem at all)

3) Likert scale (1 - very easy, 5 - very difficult)

Table 2. Survey setup for EVAL dataset.

The second dataset (called GRADE dataset) contains the students' performance in the same courses, according to the ECTS (European Credit Transfer and Accumulation System) grading system. Table 3 shows the structure of both datasets, grouped by media formats.

| Type of course | Number of Courses | EVAL Dataset (N=253) | GRADE Dataset (N=616) |
|-------------------------------------|-------------------|----------------------|-----------------------|
| Type 1: Video-based course | 4 | 72 | 129 |
| Type 2: Hypertext-based course | 9 | 91 | 273 |
| Type 3: Audio-based course | 4 | 35 | 87 |
| Type 4: Audio and text-based course | 4 | 55 | 127 |

Table 3. Structure of EVAL and GRADE datasets

Methodology and Statistical Tools

In order to prove the reliability of the collected data, Cronbach's alpha was computed. In general, only nonparametric methods (sometimes called distribution-free) were applied to Likert scale data from both datasets. The hypothesis of normality was checked with the help of both Kolmogorov-Smirnov and Shapiro-Wilk tests of normality. The differences between groups were tested with the help of the Kruskal-Wallis test. In order to measure the inhomogeneity of two particular groups, the Mann-Whitney U-test was employed. For nonparametric correlations, Spearman's rho was calculated. The level of significance (alpha level) was $p = 0.05$ for all tests.

Consistency and Normality of the Datasets

In the examined sample, Cronbach's alpha is equal to 0.874, which is above the recommended 0.7 (de Vaus, 2001). This result exhibits statistically acceptable internal consistency and confirms that all survey items can be included in the final scale for further analysis.

The distribution of each observed variable in both datasets was tested with the help of Kolmogorov-Smirnov and the more powerful (Stevens, 2002) nongraphical Shapiro-Wilk tests, which proved the hypothesis that significant departures from normality exist ($p < 0.05$) in both datasets GRADE and EVAL. Non-normality of the survey variables was thus statistically proved, and the choice of the less restrictive (Gibbons, 1993) nonparametric methods was confirmed.

ANALYSIS AND INTERPRETATION OF RESULTS

General Observations

Once nonparametric methods were confirmed as the appropriate choice by the normality tests, Kruskal-Wallis statistics (Chalmer, 1987) were employed in order to find inhomogeneities in the datasets.

The first hypothesis based on research question (1) is:

H1: If a particular course type was evaluated by the students significantly differently as compared to the whole population, then this inhomogeneity will be visible in the test results.

The results of the Kruskal-Wallis test (cf. table 4) for the 4 course types indicate the lack of statistically significant differences between particular course types for the majority of the survey items. For example, important questions such as: "Please give a grade for the course" and "How do you evaluate the overall design of the course?" show no statistical significance to reject the null hypothesis. No special preferences for a particular type of content were identified in the test.

Nevertheless, two items exhibit significant differences between the course types. These items are the difficulty of a course as perceived by the students, and the amount of work (in hours per week) spent within a particular course. This finding reflects the fact that the perceived difficulty of the 4 course types varies within broad limits. However, at this stage it is difficult to identify the roots of the inhomogeneity. In terms of student perception, the different course types seem to fare quite evenly. These results suggest a negative answer to research question (1). However, the perceived difficulty assigned to different

course types is not homogenous. Perceived difficulty is not necessarily an acceptable evaluation variable. Additional research on this issue is described later (cf. subsection "Factors Influencing Student Evaluations").

| Survey Question | Chi-Square | df ¹⁾ | Asymptotic Significance |
|---|------------|------------------|-------------------------|
| Readability | 2.674 | 3 | 0.445 |
| Time required to access multimedia material | 7.046 | 3 | 0.070 |
| Quality of videos if applicable | 0.973 | 3 | 0.808 |
| Quality of sound if applicable | 1.599 | 3 | 0.660 |
| Navigation in the courses website | 1.400 | 3 | 0.705 |
| The specific multimedia format | 6.947 | 3 | 0.074 |
| Overall design of the course | 3.295 | 3 | 0.348 |
| How many hours per week | 55.729 | 3 | 0.000 |
| Please give a grade for the course | 5.698 | 3 | 0.127 |
| How difficult was the course | 27.425 | 3 | 0.000 |
| Language problem in understanding content | 0.451 | 3 | 0.930 |

1) Degrees of freedom

Table 4. Kruskal-Wallis test results for EVAL dataset (course type as a grouping variable)

The same test method (Kruskal-Wallis test) was applied to the GRADE dataset. The hypothesis based on research question (2) is:

H2: Student performance depends on the type of course.

The test results show the existence of significant differences in grading between the course types. Thus the test does not reject the hypothesis.

The Kruskal-Wallis test analyzes ranked data. Table 5 shows a summary of these ranked data and also the mean rank of each course type for the two evaluation variables. It can be observed that video-based courses obtain the best evaluation (lowest mean rank) across the entire dataset. At the same time, students showed the worst performance (the highest mean rank) in these courses.

| Type | N | Mean Rank of Student Grades | N | Mean Rank of Student Evaluation ¹⁾ |
|-----------------------------|-----|-----------------------------|-----|---|
| Video-based course | 129 | 345.20 | 70 | 108.31 |
| Hypertext-based course | 273 | 305.82 | 90 | 133.80 |
| Audio-based course | 87 | 295.86 | 34 | 127.65 |
| Audio and text-based course | 127 | 285.64 | 54 | 128.00 |
| Total | 616 | | 248 | |

1) Item "Please give a grade for the course"

Table 5: Mean Ranks

The initial findings can be summarized as follows:

1. The EVAL dataset exhibits no statistically significant differences between course types apart from questions involving the measurement of the difficulty. It was shown that no special preferences exist toward particular course types in the examined population as a whole.

2. The only inhomogeneity factor in the EVAL dataset is difficulty. Video-based courses were confirmed to be the most difficult ones among the 4 course types.
3. The GRADE dataset exhibits statistically significant differences between course types. This means that research question (2) can be answered positively. The worst student performances were found in video-based courses.
4. Despite the perceived difficulty and low student marks, video-based courses received the best evaluations by the students.
5. A comparison of the mean ranks in table 5 gives a strong impulse towards comparing the student evaluations of video-based and hypertext-based courses. Even though no differences in the evaluations of the 4 types exist as a whole, differences between groups, when compared pair-wise, might be significant. This hypothesis will be examined in the next section.

VIDEO-BASED VERSUS HYPERTEXT-BASED COURSES

Among the four course types, video-based and hypertext-based courses are most different from each other in terms of content delivery. While videos offer a richer multimedia experience similar to a real lecture, hypertext means that the student has to absorb the information through "dry" reading. There is evidence that media variety is a positive predictor of delivery medium satisfaction (Arbaugh and Rau, 2007). Taking this into consideration, the following hypothesis, according to research question (3), is established:

H3: Video-based courses obtain better evaluations from students than hypertext-based courses.

As already shown in table 5, video-based courses receive the best evaluation among the 4 studied course types, while hypertext-based courses trail last. A further statistical comparison with a Mann-Whitney test confirmed the hypothesis that video-based courses are evaluated significantly ($p < 0.05$) better than hypertext-based courses.

It can be concluded that a more "dynamic" mode of multimedia content delivery (such as videos) in distance learning is better accepted than a rather static mode – namely reading an instructional text.

Additionally, an interesting discrepancy regarding video-based courses can be observed between the overall evaluation by the students, the perceived difficulty and the grades students get. While students rate video-based courses as the best, they seem to get the worst grades in these courses (mean rank is 345.20) and they also state that these courses are the most difficult ones.

On the other hand, hypertext-based courses receive the worst marks from students, although they are evaluated as not that difficult. The average grade that students receive in this type of course is significantly better than in video-based courses (mean rank is 305.82). It is rather comparable to the other two types – audio-based and audio and text-based (mean ranks are 295.86 and 285.64, respectively).

Despite the perceived difficulty and low average grades, students nevertheless prefer to obtain the learning material in a multimedia form, similar to a traditional campus-based lecture. Hypertext-based courses, being not so "entertaining", are evaluated significantly worse.

Audio-based versus Audio and Text-based Courses

Another pair of course types that is worth comparing is audio-based and audio and text-based courses. As briefly explained in the first section, these two course types are generally quite similar. The main difference is that a text transcript of the spoken audio material exists in the audio and text-based type. Both types offer a spoken lecture synchronized with lecture slides.

Obviously the audio and text-based course type offers an additional channel of learning compared to only audio. The motivation for creating audio and text-based courses rests on the idea that with audio alone the listener may miss important parts of a lecture if the lecturer does not stress them sufficiently or the listener is distracted for some reason. Based on these considerations, and in accordance with research question (4), the following hypothesis is established:

H4: Students favor a type of audio-based course that offers a transcript of the spoken content.

The statistical analysis partly supports this assumption. A nonparametric Mann-Whitney U-test was used to compare the questionnaire items only for the two particular course types. While most of the compared questionnaire items seem to be fairly the same for both types of courses, students state with a considerable level of significance ($p < 0.05$) that audio-based courses are more difficult than audio and text-based courses. However, most statistics for the two types are very similar. A comparison between the grades achieved by students in the two course types shows no significant difference whatsoever. The answers to the item "Please give a grade for the course" also display only very insignificant differences.

Nevertheless, some students explicitly stated their preference for a written transcript of the spoken lectures in the free comment section of the questionnaire. One student of an audio-based course asked: "Please not only slides, but also text as in a lecture." Another one recommended "... to provide the written part of the lecture (not the slides) as e.g. a pdf-document".

As a consequence, the hypothesis that students of an audio-based course would prefer to have a transcript of the spoken content cannot be confirmed. Still, the students' comments as well as their evaluations of the perceived difficulty of both course types indicate that audio and text-based courses are better accepted than just audio-based courses.

Factors Influencing Student Evaluations

One observation described above (cf. subsection "General Observations") was that students evaluate video-based courses best although this type of course is perceived as the most demanding one. Therefore, in connection with research question (5), we set up the following hypothesis:

H5: The evaluation of the course does not depend on its perceived difficulty but on other factors.

In order to examine the correctness of this assumption, the factors that influence the evaluation of a course type and cause the differences between the courses had to be identified. Nonparametric correlation analyses of each group of courses were performed in order to find the top five factors among the survey items that exhibit the strongest correlation with the overall evaluation of a course ("Please give a grade for the course" item). Thus the strongest factors influencing the overall evaluation of a course type can be singled out. Provided that the correlations are strong enough, these factors can be interpreted as the most important drivers pro or contra a specific media format.

An extra measurement in this analysis – an "aggregated evaluation" variable – was artificially added to the data set. The idea behind this method is to sum all the answers of the Likert scale questions that belong to a single logical group in order to obtain an aggregated indicator for the whole group (Pedhazur and Pedhazur Schmelkin, 1991). In our case, answers to the survey questions from the "How do you rate the following" group in table 2 were added up. As described before, the survey data displayed a sufficient level of consistency in order to justify this step. The new variable was included in the correlation analyses.

The Spearman's rho statistic was chosen as a nonparametric substitute for the common Pearson correlation coefficient in order to be able to measure the rank variables better. Table 6 shows the top 5 items for each course type that correlate the most with the overall course evaluation item ("Please give a grade for the course"). The correlation values are negative because of the inverted scale of the latter item.

In almost all cases, the "overall design of the course" and "aggregated evaluation" variables show the strongest correlation with the overall mark assigned by the students to a particular course. This fact confirms that the initial choice of questionnaire items outlined in table 2 was suitable. It also confirms that these items represent the most important drivers for the students' evaluations. Table 6 also illustrates which factors affect the overall evaluation of the groups in the most significant way:

1. Video-based courses: quality of video, multimedia format and sound (the latter with no statistical significance but a fair correlation coefficient) – these features describe the strongest sides of video-based lectures.
2. Hypertext-based courses: As one could expect, good readability and sometimes sound quality add value to this type of course (in some hypertext-based lectures, an audio or video introduction is provided which students probably value highly as compared to the pure hypertext of the rest of the lecture).
3. In audio-based courses, the specific multimedia format is the strongest driver of the overall evaluation (i.e. the specific combination of an audio track and slides).
4. Audio and text-based courses exhibit readability among the top 5 characteristics. This once again supports the observation that an additional lecture transcript is particularly valuable for the students.

Having looked at the items that exhibit the highest correlation with the central item "Please give a grade for the course" for the 4 course types, it is interesting to note that the only item that does not show a significant correlation ($p > 0.01$) with this item is "How difficult was the course?"

The results presented in this section confirm the hypothesis that perceived difficulty is not at all a factor in students' evaluation of courses. The conclusion is that students do not evaluate a course according to how hard and complicated they found it, but according to the technological approach applied to the course and the content of the course.

| Course Type | Survey Characteristic | Correlation Coefficient ¹⁾ |
|---------------------------|-----------------------------------|---------------------------------------|
| Video | Overall design of the course | -0.61 |
| | Aggregated evaluation | -0.46 |
| | Quality of videos if applicable | -0.42 |
| | The specific multimedia format | -0.40 |
| | Quality of sound if applicable | -0.24 (p > 0.05) |
| Hypertext course | Overall design of the course | -0.65 |
| | Aggregated evaluation | -0.65 |
| | Readability | -0.53 |
| | Quality of sound if applicable | -0.49 |
| | The specific multimedia format | -0.49 |
| Audio-based course | Overall design of the course | -0.75 |
| | The specific multimedia format | -0.68 |
| | Aggregated evaluation | -0.65 |
| | Quality of videos if applicable | -0.60 |
| | Navigation in the courses website | -0.48 |
| Audio and text | Overall design of the course | -0.70 |
| | Aggregated evaluation | -0.67 |
| | The specific multimedia format | -0.62 |
| | Navigation in the courses website | -0.59 |
| | Readability | -0.58 |

1) Spearman's rho statistic

Table 6. Top-5 correlations of survey items in the EVAL dataset

SUMMARY AND CONCLUSIONS

The results presented and discussed in this paper offer insights into student preferences for different types of web-based learning. The field of web-based learning is still actively evolving. Various technologies supporting online learning are available. However, there is still no definitive answer to the question of whether different content delivery methods are significantly different regarding the students' learning experience and utility.

This paper examined if various media types in web-based courses have an effect on student performance in and evaluation of the courses. In an additional drill-down, pairs of course types were compared in order to detect finer nuances in the perception of different media formats: the most heterogeneous pair – video-based versus hypertext-based – and an almost identical pair – audio-based and audio and text-based courses. Finally we analyzed which factors have most influence on the students' evaluation of the courses.

The five research questions put forward at the beginning of this paper were answered with the help of statistical tests. Based on the students' evaluations and performances, the answers can be summarized as follows:

1. In terms of student perception, the different course types seem to be evaluated quite similarly.
2. Student performance in a course – in terms of the grades students receive – seems to depend on the content delivery type of the course. However, this conclusion might be biased because possibly the subject matters of these courses are more difficult as such. The particular student learning styles, which were not object of this study, might also have affected this observation (Eom, Wen and Ashill, 2006).

3. Despite its perceived difficulty, the video-based course format proved to be the students' favorite. This course type was evaluated significantly better than the more conventional hypertext-based courses.
4. Written transcripts of spoken material in courses using audio are appreciated by the students. However, this finding could not be retained with statistical significance.
5. Students do not evaluate courses according to how difficult they find them. Other factors such as technical quality and content seem to play a much more important role.

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