Fly: Studying Recall, Macrostructure Understanding, and User Experience of Canvas Presentations

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ABSTRACT
Most presentation software uses the slide deck metaphor to create visual presentation support. Recently, *canvas presentation tools* such as Fly [6] or Prezi [9] have begun to use a zoomable free-form canvas to arrange information instead. While their effect on authoring presentations has been evaluated previously, we studied how they impact the audience. In a quantitative study, we compared audience retention and macrostructure understanding of slide deck vs. canvas presentations. We found both approaches to be equally capable of communicating information to the audience. Canvas presentations, however, were rated by participants to better aid them in staying oriented during a talk. This makes canvas presentation tools a promising slideware alternative.

Author Keywords
Canvas presentations; slideware; zoomable user interfaces

ACM Classification Keywords
H.5.2 Information Interfaces and Presentation: User Interfaces—*GUI*; H.1.2 Information Systems: User/Machine Systems—*Human information processing*

INTRODUCTION
Slide-based visual presentation support, commonly known as *slideware*, is prevalent in talks in research, industry, education, government, and many other areas. The slide metaphor employed by software such as Microsoft's PowerPoint or Apple's Keynote originates from the technical restrictions of physical slides used on overhead projectors. Today, presentation visuals are usually displayed using a computer connected to a video projector. This removes the necessity of showing a series of slides, one at a time, and makes the slide format somewhat arbitrary. Consequently, this format has been criticized repeatedly for the limitations it imposes on authors and presenters [8, 12]. In particular, it requires authors to map their content to a linear sequence of equally-sized chunks, making it especially difficult to present complex topics that have more than one logical dimension or are highly interconnected [5, 6].

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Among the attempts to mitigate these problems of slideware, several dismiss the slide metaphor in part or entirely. Instead, they place either the slides [5] or their individual elements [6, 9] on an infinite *canvas.* Presentation authors then define viewports and transition paths across the canvas to define the presentation sequence. This approach has been shown to afford easy overviews, and to offer more flexibility in chunking content to the author [6].

Previous research also suggests that canvas presentations may be beneficial to the audience, because content macrostructure can be made easier to grasp; especially spatial learners may benefit from this format [5]. However, this assumption has not been evaluated in a quantitative study so far. We conducted such an experiment comparing canvas-based presentations and their slideware counterparts, by measuring *recall of facts* and *understanding of macrostructure* among audience members, and by gathering results on their *subjective assessment* of these presentations.

RELATED WORK
After a summary of canvas presentation tools, we discuss research on human cognition in the context of canvas talks.

Authoring canvas presentations
While early zoomable user interfaces [1] were also used in talks occasionally, several tools have been designed specifically with presentation support in mind [5, 6, 9]. CounterPoint [5] broke new ground by positioning PowerPoint slides inside a zoomable user interface. It lets authors place slides at varying distances from a virtual camera and create a spatial layout of slides that in itself communicates the macrostructure of the talk. Overviews can be created easily by zooming out and presenting the slide arrangement to the audience. This model was also adopted by pptPlex[1].

Fly [6] completely abandoned the slide metaphor, letting authors put content elements (text, figures, etc.) directly on a canvas. Authors are no longer bound by the slide frame, and do not need to split subtopics into fixed-size chunks. Two studies comparing authoring with Fly to using the traditional slide deck format showed that the resulting Fly documents were richer and better represented the structure of connected topics [6]. Authors also embraced the possibilities of the non-linear layout of information and expressed a clear preference for canvas layouts. Prezi [9] is a successful web service with a similar concept.

[1] http://www.officelabs.com/projects/pptPlex

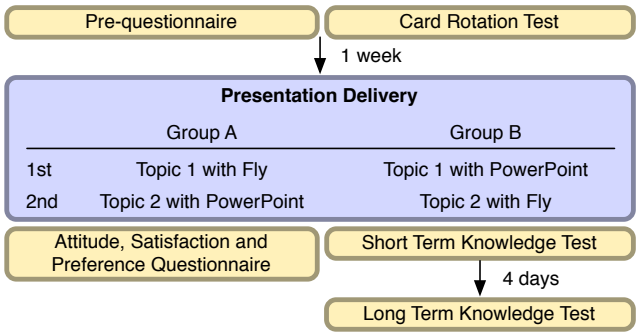

Figure 1. Study design. All participants performed the pre- and post-experiment activities (yellow). The main experiment (blue) split participants into two groups, switching the order of tools (not topics).

Viewing canvas presentations

Besides the authoring process, presentation delivery could also benefit from the canvas layout. Plausible reasons for this are the increased visibility of the macrostructure, the potential to leverage the spatial abilities of the audience, and less fragmentation of the material. Content macrostructure and its relations can be incorporated into the spatial layout, and can be communicated to the audience implicitly through spatial overviews and animated viewport transitions. The presenter hence does not need to express them verbally through written or spoken text, as is necessary in slide-based presentations. This reduces cognitive load for the audience [7].

Successive viewports can overlap, so content can be presented in a less fragmented way: related topics stay together, and more relationships are represented spatially. Especially animations between viewports can offload some of the viewers cognitive burden to the human perceptual system by exploiting the perceptual phenomenon of object constancy that enables viewers to track element relationships without thinking about it [10]. By shifting load from the verbal to the visual cognitive channel, the audience can exercise a larger portion of their memory resources [5]. This reduction of the auditive/verbal cognitive load is especially useful in a presentation scenario in which the oral narration must be followed and processed continuously.

On the other hand, audience members less skilled in spatial orientation might be overburdened by a canvas presentation, and following Clark's argument that different media will not improve learning [2], a large corpus of studies exists that has not been able to document significant effects of different media on learning [11]. It is even unclear whether canvas presentations should be considered a different medium or just a different tool.

In summary, while evidence exists that canvas tools benefit authors, this has not been studied for presenters or the audience. Presenters and listeners might even be overburdened by the complexity, and listeners might retain less information than with standard slideware. Our study aimed to address this question.

STUDY DESIGN

In our study, we showed two instructional talks to two audiences (fig. 1). Each group separately attended two presentations of 15 minutes each on two different topics. One of the presentations used PowerPoint, the other Fly, representing the *slide deck* and *canvas* conditions. We formulated the following hypotheses:

H1: There will be no significant difference for fact retention between the canvas and slide deck condition.

H2: In the canvas condition, participants will perform better for macrostructure recall and transfer questions.

H3: The canvas visuals will provide participants with a better orientation of talk progression.

H4: Participants will find the structure of the canvas presentations easier to comprehend.

H5: Participants will find the amount of content shown on the screen at a time more adequate in the canvas condition.

We recruited our participants from the students of an introductory HCI course. Each participant was asked to fill out a pre-questionnaire and to assess their spatial ability using the card rotation test [3]. According to this data, students were divided into two groups with a counterbalanced mix of different ages and spatial vs. verbal learners. Students with prior knowledge in any of the two topics or those that were not very proficient in the language of the presentation were excluded from the experiment. This resulted in 26 participants in total, 23 male, 3 female, 13 per group. Ages ranged from 23 to 35 (median 27).

To understand the talks no prior knowledge about the content was needed; both topics, "Fixed-Gear Bicycles" and "Convergent Evolution", were uncommon and independent from each other. We counterbalanced the order of the canvas and slideware conditions, but not the order of topics, since the latter was unlikely to create learning effects.

Personality, mood, and performance of a speaker and the interaction between speaker and audience can have a strong impact on the quality of a presentation. To minimize bias through speaker/audience interaction or different speaker performances, we presented all talks as prerecorded video presentations. Without the speaker physically present, it was important to have an engaging narrative, hence a professional broadcast speaker recorded the spoken commentary. Spoken texts were kept simple and informal to match a face-to-face presentation. To avoid differences in pronunciation, emphasis, and elaborateness, both conditions shared the same audio material; the recordings were split into segments that could be mapped to the visuals of both formats. Using recordings instead of a live presentation has been shown not to have a significant influence on learning [4].

An important factor in the experiment was the authoring quality of the presentation documents. Since presentation visuals for each of the two topics were needed in both formats, the challenge was to ensure that the documents on the

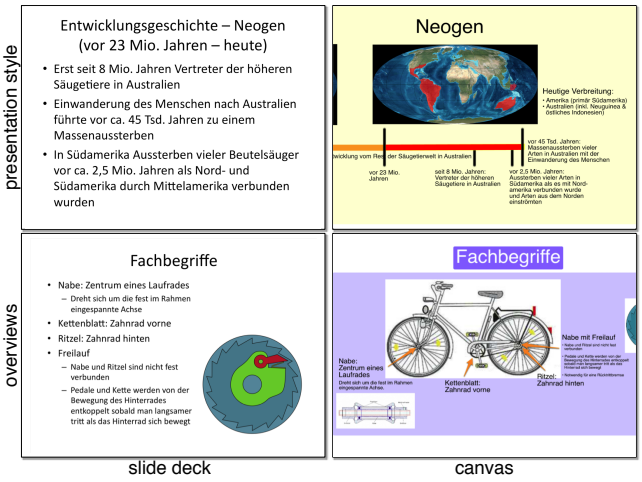

Figure 2. Presentation style and overviews in the slideware (left) and canvas (right) condition. Top: the slideware layout is confined to the frame, whereas the canvas visuals span multiple viewports. This can be seen, e.g., at the timeline, which extends to the left past the frame. Bottom: different strategies to visualize overviews in slideware and on a canvas.

same topic contained the same content. Because of the fundamentally different formats of Fly and PowerPoint, there was no exact way to match document content. To reduce the risk for bias, an external and experienced presentation author (31 years) who was not involved with the study otherwise created all four documents.

In the resulting documents, the Fly visuals contained more unique layouts compared to an image with bullet points, and were more verbose for some sections. Some layouts were only possible because of the canvas-based format and could not be adapted to PowerPoint. The biggest layout difference occurred in the Convergent Evolution talk: the development history and present-day distribution of marsupials was integrated into a big timeline layout with an illustration of geologic eras. In PowerPoint, for the same topic, the development history was covered with a series of text-based slides that showed one era each with the illustration on an extra slide (fig. 2 top). Naturally, the overviews in Fly used more graphics and were structured spatially, while the overviews in PowerPoint used more text and were structured linearly. For example, for the introductory section of the fixed-gear bicycle presentation, a large graphic of a bicycle was used for the background on which the explanations of the basic concepts of bicycle technology were placed (fig. 2 bottom). The Fly visuals contained additional overviews that previewed and recapitulated single topics.

After both presentations were over, participants immediately filled out a *short term knowledge* test and a *preference and commentary* questionnaire (fig. 1). Four days later, they filled out a *long term knowledge* test. To measure knowledge transfer, the two knowledge tests asked for content and macrostructure facts with retention questions, and for content understanding with problem-solving transfer questions. To gain insight into the participants' attitude towards and

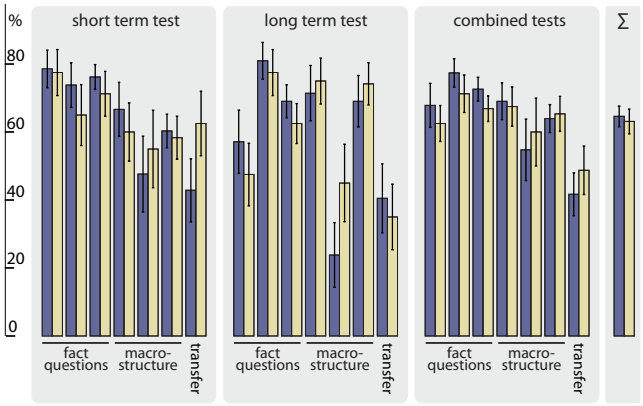

Figure 3. Percentage of correct answers to questions by presentation method for the two tests by question categories, combined tests, and all questions (canvas=dark blue, slideware=light green, error bars ± 1 *SE*). Both techniques performed equally well in terms of retaining facts, structure, and transferring knowledge. Only the short-term knowledge transfer question shows a significant difference.

satisfaction with the presentations, the questionnaire asked several Likert scale questions (table 1).

STUDY RESULTS

Fig. 3 shows knowledge test results for both conditions. For the short term transfer questions, the mean score is higher in the slide condition (paired t-test, p=.029). However, this is the only significant difference for all question categories.

Regarding the differences between short term and long term recall, the only significant result was that group A performed worse in the long term test for the slide condition (paired t-test, p=.003). Regarding the comparability of topics, paired t-tests did not show significantly more correct answers for any topic in the short term tests (p=.071), long term tests (p=.352), and in total (p=.145).

Table 1 lists the responses to our attitude and satisfaction questionnaire. A related samples Wilcoxon signed rank test showed that participants significantly preferred the canvas over the slide condition in questions A4, S5, S6, and S7. No other differences were significant.

In the spatial cognitive ability test, participants received a mean score of 127.32 (SD=21.011) out of 160. An independent samples t-test showed no significant difference between the mean scores of both groups (p=.837). We found no correlation between spatial ability and percentage of correct answers for any groups, talks, or conditions. Interestingly, the higher spatial cognitive ability, the more individuals found the amount of content on the screen (S2) too much (Pearson's r=.469: p=.003). However, we found no correlation between spatial ability and format preference.

Although we tried to balance members between groups, a t-test found group B performed slightly better than group A in both questionnaires. However, the difference is only significant for macrostructure retention (p=.080). Also, group A found the presentation visuals less distracting (p=.043).

	Question	*Mdn* (canvas / slide)	*p*
A1	The presentation was interesting.	2 / 2	0.756
A2	I liked the presentation visuals.	2 / 2	0.204
A3	I liked the narration of the presentation.	2 / 2	0.248
A4	I liked the presentation overall.	**2 / 3**	**0.047**
S1	The speed of the presentation was too slow.	3 / 3	1.000
S2	The amount of content shown on the screen at once was too much.	3 / 2	0.058
S3	The visuals distracted me from the narration.	4 / 4	0.755
S4	I had sufficient time to look at all the content.	2 / 3	0.805
S5	The structure of the talk was easy to understand.	**1 / 3**	**0.048**
S6	I always knew which part was currently shown.	**1 / 3**	**0.006**
S7	I always knew how far the talk had progressed.	**2 / 3**	**0.001**

Table 1. The questions (Likert scale 1–5, 1 for strongest agreement) from the attitude and satisfaction questionnaire. A related samples Wilcoxon signed rank test shows significant difference in four cases, all in favor of canvas presentations.

Discussion

Based on the fact recall results, we can accept H1. As the factual information is represented similarly in both formats, it seems that the presentation form alone does not influence fact retention. Although we expected the spatial arrangements in the canvas condition to help participants understand relations between topics (H2), the results do not support this. Consequently, there is no evidence to suggest that either canvas presentations or slide based ones are better suited to convey information to an audience. However, the results support H3; there were significant differences in favor of the canvas condition for the statements about orientation in content (S6) and temporal progress (S7). We also accept H4; participants found the canvas structures easier to understand (S5). On average, participants found the amount of content on the screen at a time more adequate in the canvas condition (H5), but this result was not significant (S2).

Limitations of the study

Several limitations have to be kept in mind when interpreting these results. First, canvas-based visuals are still new and exciting, which may have influenced participants. Second, our study used educational presentations with a focus on knowledge transfer. Other talks primarily focussed on conveying motivation, emotion, etc., may benefit even more from a canvas layout, again partly due to its novelty. Third, the talks were rather short and author and audience were informed beforehand of the study design and the knowledge tests. They may therefore have put more effort into their performance (cf. the Hawthorne effect).

SUMMARY AND FUTURE WORK

We evaluated the canvas presentation format against a baseline slide deck format to investigate the effects of canvas presentations on the learning performance and preferences of a student audience. We found that, while learning performance was largely the same in both cases, students clearly preferred the canvas-based presentation.

If we distinguish between three key activities associated with presentations—authoring, presenting, and attending—, canvas based presentations have now been analyzed in the context of the first and the third activity. We still have little data, however, on the effect of this format on the cognitive load of the presenter during her talk. Examining these effects could help understand the value of canvas presentations for all three user groups: authors, presenters, and the audience.

RepliCHI

We invite replication of this study. All materials required to replicate this experiment can be downloaded[2].

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