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The Course Glancer - Leveraging Interactive Visualization for Course Selection

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ABSTRACT

Lifelong learning requires the consistent and continued development of one's knowledge, skills, and competencies. However, due to the extensive choice of courses offered at today's institutions of higher learning, students face a risk of choice overload in their selection of (elective) courses. As current findings in choice overload literature do not refer to student samples in educational settings nor do they consider the use of interactive visualization formats, the use of interactive visualization in higher education organizations seems a promising way to support course selection that fits educational needs. All the more as previous visualization approaches to overcome table-based visualizations or online course catalogues primarily aim at communicating curricular content and structure to different university stakeholders, while disregarding students. We thus introduce our work-in-progress on an interactive visualization tool called the Course Glancer. The Course Glancer supports students' decision-making ability when confronted with a variety of learning offers while taking electives of a bachelor's degree program in business administration. The tool provides support for gaining an overview on all available courses and their categories, and for rapidly comparing course alternatives. In doing so, it can help to clarify course preferences and finally to foster students' confidence of not having overlooked an important course option. This is in line with Shneiderman's information-seeking mantra as a must-have for effective cognitive processing: Overview first, zoom and filter, then details-on-demand. We use this mantra in connection with Norman's usability principles of discoverability, affordances, feedback, constraints, mapping, and consistency. An example of how we use constraints is that course comparison is limited to juxtaposing two courses only. This functionality considers latest evidence from using eye-tracking studies that revealed that human beings tend to distribute their attention in an unbalanced manner and focus mainly on the two options that seem the most promising alternatives. To enrich the empirical research on choice overload, we plan to focus on psychological effects in the use of the Course Glancer. These include subjective, moderating factors (e.g., decision style) and behavior-related measures. The latter refer to subjective states (choice satisfaction, decision regret, decision confidence) or behavioral outcomes (e.g., choice deferral, option selection). Beyond these, group-related effects should also be analyzed in future research, for example, if interacting with our tool can stimulate information exchange processes within expert groups of higher education organizations (e.g., in the context of accreditation procedures or curriculum planning).

Keywords: Choice overload, Course selection, Decision-making, Higher education, Interactive visualization, Lifelong learning

INTRODUCTION

Lifelong learning requires the consistent and continued development of one's knowledge, skills, and competencies. However, due to the extensive choice of courses offered at today's institutions of higher learning, students face a risk of choice overload in their selection of course electives. This cognitive state is characterized by "the difficulty of making a decision when multiple options are available" (Manolică et al. 2021: 2). It relates to decision paralysis, high evaluation costs, regret anticipation, inaction, and delay (Manolică et al. 2021; Schwartz, 2004; Toffler, 1970). Students are thus keen to avoid regret or disappointment. They tend to compare possible consequences of a certain option with other consequences that would occur when making another choice. In terms of anticipated emotions, they may experience emotions of regret in their cognitive calculations based on the subjectively expected utility (Edwards, 1954; Loomes and Sugden, 1982, 1986). They may not be able to make fully rational, objective decisions (March and Simon, 1958; Simon, 1959). A course decision must be made under uncertainty. In fact, "the expected outcomes are disparate and often contradictory … and different courses are selected with different objectives in mind" (Babad, 2001: 471). This implies the students' challenge to elaborate worthy alternatives. Especially in university environments, course decisions are sequential and interdependent (Babad, 2001). Course decisions influence students' "future by widening or delimiting further study and future educational and occupational possibilities" (Babad, 2001: 469; see also Ma et al. 2021). In terms of finding, analyzing, and making use of new information to manage oneself in a complex knowledge economy, course selection affects their task as "knowledge workers" to develop their decision-making ability in higher education organizations (Drucker, 1959, 2005). The resulting psychological tension between exploration and exploitation of knowledge certainly feels like "being thrown into an ongoing, unknowable, unpredictable streaming of experience in search of answers to the question, 'what's the story?"' (Weick et al. 2005: 410).

To contribute to this "story", we thus introduce our work-in-progress on an interactive visualization tool called the *Course Glancer*. The Course Glancer supports students' decision-making ability when confronted with a variety of learning offers while taking electives of a bachelor's degree program in business administration. Previous visualization approaches to overcome table-based visualizations or online course catalogues primarily aim at communicating curricular content and structure to different university stakeholders, while disregarding students (e.g., Nelson-Fromm and Fagen-Ulmschneider, 2022; Siirtola et al. 2013; Zucker, 2009). This tool, however, provides support for students for gaining an overview on all available courses and their categories, and for rapidly comparing course alternatives. In doing so, the application can help to clarify course preferences and finally to foster students' confidence of not having overlooked an important course option (adapted from Eisenhardt, 1999).

Before presenting our tool and its rationale, we explain the impact of interactive visualization on choice overload. The paper concludes with an outlook on further research and emerging application contexts.

INTERACTIVE VISUALIZATION AND CHOICE OVERLOAD

The *Conceptual Model of the Impact of Assortment Size on Choice Overload* (Chernev et al. 2015; Thai and Yuksel, 2017) serves as overall framework to anchor the role of interactive visualization in the choice overload debate. It indicates how the relation between the number of options and perceived choice overload is moderated by objective and subjective factors. Objective moderators refer to aspects of *decision task difficulty* and *choice set complexity*, while the subjective elements correspond to *preference uncertainty*, *decision-making styles*, and *decision goals* (Thai and Yuksel, 2017). The former "relate to a choice problem and are applied to all individuals" (Thai and Yuksel, 2017: 4) and the latter "reflect personal knowledge and motivations when dealing with the choice problem" (Thai and Yuksel, 2017: 4). Accordingly, the influence of the presentation format is discussed regarding decision task difficulty (Chernev et al. 2015, Thai and Yuksel, 2017). As these findings do not refer to student samples in educational settings nor do they consider the use of interactive visualization formats (Diehl, 2005; Diehl et al. 2003; Hoch et al. 1999; Langner and Krengel, 2013; Mogilner et al. 2008; Townsend and Kahn, 2014), the use of interactive visualization in higher education organizations seems a promising way to facilitate (dual-coded) cognitive processing supporting course selection that fits educational needs (e.g., Paivio, 1986). It reduces mental efforts that impose on working memory (Cooper, 1998) whereby extraneous cognitive load is the most relevant component. It "is imposed by the designer as they organize and display information" (Guo et al. 2018: 5). From the cognitive load perspective (Chandler and Sweller, 1991, 1992; Sweller, 1993; Sweller, 2005; Sweller et al. 1998), it thus meets students' perceptual ability in visual design to overcome choice overload. In this context, elaborating learning offers visually supports "active processing of information to achieve understanding" (Pirolli and Russel, 2011: 1). From the students' perspective, the guiding question in course selection is thus the following (Weick, 1979; Weick et al. 2005): *How can I know what I want to learn until I see which learning offer I am elaborating visually?*

THE COURSE GLANCER: A PILOT APPLICATION FOR SELECTING ELECTIVES IN BUSINESS ADMINISTRATION

The main purpose of the Course Glancer application is to guide students through their options when taking electives at a bachelor's degree program in business administration (BBA Glancer). Regarding the features for effective cognitive processing, the design of the BBA Glancer (see also *courseglancer.visual-literacy.org/glancer/bba*) is in line with Shneiderman's information-seeking mantra: Overview first, zoom and filter, details-on-demand, relate, history, and extract (Shneiderman, 1996). We use this

mantra in connection with Norman's usability principles of discoverability, affordances, feedback, constraints, mapping, and consistency (Norman, 2013).

Overview First

To assist in deeper understanding, access to information must be easy and *discoverable* (Norman, 2013). It should indicate "how to use an object by interacting with the object" (Novensa and Munggana, 2018: 1) Providing a big picture with all components and functionalities fosters the ability to discern and select relevant information. Some useful aspects and considerable patterns can only be seen from this vantage point (Craft and Cairns, 2005). In our case, students discern a visual map with spatially segregated courses. For instance, it becomes clear immediately which elective courses belong to the core electives of the bachelor's program or to the liberal arts area. The whole view further communicates so-called *affordances* that give students "a clue of how the object … can be used" (Novensa and Munggana, 2018: 2) The icons displayed in each segregated space are examples of such "action possibilities" (Kannengiesser and Gero, 2012: 50) that make the application intuitive. The mouse-over function with first course information (e.g., course title, lecturer) can further reinforce perceived affordance.

Zoom and Filter

The use of zooming and filtering aims at reducing visual complexity. While zooming, students try to adjust the size and position of the displayed course icons in relation to the visual environment (Craft and Cairns, 2005). Following their intuitive interest, they can zoom into a desired area of visual map (e.g., core electives). Accordingly. our zoom-in function corresponds to the direction of the mouse wheel. Following the requirement of *mapping* defined as "relationship … between control and its effects" (Novensa and Munggana, 2018: 2) in visual design (Norman, 2013), it becomes "easy for … [students] to scan, recognize, and recall images rapidly" (Guo et al. 2018: 2). They can "detect changes in size, color, shape, movement, or texture" (Guo et al. 2018: 2). In contrast, the use of filters doesn't accomplish adjusting visual representation. To simplify students' cognition by electively revealing interesting learning offers, our tool thus allows them to control which courses should be visually emphasized (Craft and Cairns, 2005). By means of a *Show-by*-Tab, courses can be filtered by choosing among given criteria such as "Competence". For instance, by using this filter, all icons in the visual map then emphasize which competence is emphasized in the course (i.e., professional, methodical, social, or personal competence). Thereby, *consistency* is important as it helps students to "recognize and apply a pattern" (Novensa and Munggana, 2018: 2) while elaborating learning offers visually. To avoid frustrations, "[a] similar activity should [always] do the same" (Novensa and Munggana, 2018: 2). For example, our tool thus ensures this design principle by assigning one filter criterion to a specific icon (e.g., professional competence as a form of competence).

Details-on-Demand

Providing additional information point by point is typical for the details-on-demand technique. In our tool, students can identify relevant courses and relate course information to the rest of the front view by clicking on the respective icon or using the mouse-over function. The possibility to select courses as an on-demand-feature allows going into detail of what can be expected of a university course (e.g., course content, learning objectives, evaluation form) without changing the context of the visual representation in which it is located (Craft and Cairns, 2005). In this context, technical *feedback* helps our students to "understand how to interact with objects and what effect … [their] actions have on the system" (Novensa and Munggana, 2018: 2). It confirms "whether an action has been successful or not …" (Novensa and Munggana, 2018: 2). For example, after changing the criterion in the Show-by-Tab (e.g., *Sustainability* with its ecological, economic, and social facet), the icons change as well to communicate the respective meaning. Besides, the Comparison-Button lights green when the Comparison-Mode is activated. Only then is it possible to compare specific courses.

Relate

A satisfying course selection implies the possibility to compare among several course characteristics. Therefore, the "Relate"-functionality allows students to look at relationships between single courses (Craft and Cairns, 2005). On the other hand, students need to know what is possible with a visualization tool (Norman, 2013). The design must "[p]rovide limits on what an object might do" (Novensa and Munggana, 2018: 2). An example of how we use such *constraints* is that course comparison is limited to juxtaposing two courses only (by Comparison-Mode). This functionality considers latest evidence from using eye-tracking studies that revealed that human beings tend to distribute their attention in an unbalanced manner and focus mainly on the two options that seem the most promising alternatives (Gluth et al. 2020). To further increase students' sense of coherence, there is the possibility to store so-called learning paths or conceptual connection lines based on a shared key concept (e.g., Baggio et al. 2015). Learning paths contain university courses whose concept-related content builds on each other. Connection lines focus on visualizing courses sharing a certain concept (e.g., Leadership).

History

An interactive visualization should provide the possibility to cancel specific settings previously activated by the user. In that sense, a history of commands enables students to replay respective sequences while refining visual exploration progressively (Craft and Cairns, 2005). We considered this requirement by implementing a "Reset"-function that can be used for fading out learning or conceptual paths or switching off applied filters. This ensures a better understanding through the comparison between current and previous states of visual representation while obtaining a general overview at the same time (Craft and Cairns, 2005).

Extract

The knowledge that students discover while elaborating learning offers visually should be useable for ongoing decision tasks. To support students in planning or organizing their individual curriculum respectively in making future course decisions, they thus have the possibility to extract appropriate courses (including learning and conceptual paths) by saving relevant course information as a pdf-file (according to Craft and Cairns, 2005).

CONCLUSION

In this paper, we have introduced our work-in-progress on an interactive visualization tool that we call Course Glancer. Based on the information-seeking mantra, it supports students' decision-making ability as knowledge workers when confronted with a variety of learning offers while taking electives of a bachelor's degree program in business administration. In terms of satisficing course decisions (March and Simon, 1958; Simon, 1959), they gain an overview on all available courses and their categories and can rapidly compare course alternatives. They get help in clarifying course preferences and develop the confidence of not having overlooked an important course option. Elaborating learning offers visually with our tool thus provides support for overcoming choice overload.

To enrich the empirical research on choice overload, we plan to focus on psychological effects in the use of the Course Glancer. These include subjective, moderating factors (e.g., decision style) and behavior-related measures. The latter refer to subjective states (choice satisfaction, decision regret, decision confidence) or behavioral outcomes (e.g., choice deferral, option selection) (Chernev et al., 2015; Thai and Yuksel, 2017). Along with the idea of stimulating students' decision-making ability, the evaluation of interactive course visualization should also include the development of a psychometric scale to measure "phenomena related to sensemaking" (Alsufiani et al. 2017: 1). In addition to previous works (e.g., Aguilar, 2016), it would be interesting to capture the relation between motivational affordances and sensemaking activities in the context of choice overload.

Beyond these, group-related effects will also be analyzed in future research, for example, if interacting with our tool can stimulate information exchange processes within expert groups of higher education organizations (e.g., in the context of accreditation procedures or curriculum planning). This could be an "initial exploration … to understand what [course] design teams perceive about the utility … for representing course design and promoting reflection on design" (Quintana and Tan, 2021: 563).

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