Microworlds as the locus of consumer education in financial advisory services

Completed Research Paper

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Abstract

The complexity of financial matters and the financial illiteracy of clients prevents informed financial decision making in current financial advisory services. We propose a novel approach to improve this situation: The advisor integrates small learning episodes directly into the service encounter. These learning episodes are implemented using the concept of explorative learning and "microworlds," i.e., small self-contained simulations. The resulting prototype is called "FinanceWorlds." An evaluation reveals that the system significantly improves client knowledge compared to traditional paper-based explanations. The paper contributes the generic principles underlying FinanceWorld's design to the knowledgebase on consumer education in financial (and other knowledge intensive) services. It thus supports practitioners in designing tomorrow's advisory encounters.

Keywords: Financial advisory services, Consumer education, Financial Literacy, Design Science Research

Introduction

In today's financial advisory encounters, clients are confronted with ever more complex financial products and constructs. Financial advisory services are constantly facing harsh criticism arising from public media coverage and industry studies (Schwabe and Mogicato 2009), which has intensified during the recent financial crisis. A recent study (Oehler and Höfer 2012) has quantified the loss due to bad financial advice to over 50 Billion Euros per year for Germany alone. Scholars (e.g. Oehler and Höfer 2012) as well as the legislators (e.g., WpHG 2011) demand the substantial enlightenment of clients regarding a financial product and its associated risks and chances. All these aspects boil down to the demand to educate the clients in order to enable them to understand the decision relevant aspects.

A work practice of rather uninformed decision making has established itself as the predominant mode of service delivery, to-date, in which clients select from a limited number of product offerings proposed by the financial advisor. Such a form of client-advisor-interaction has been described by Jungermann (1999) in his "Advice Giving and Taking (AG&T)"-model more than a decade ago. This is a dangerous practice because the advisor makes most of the relevant decisions by selecting and customizing products without proper client involvement. Kohlert and Oehler (2009) even go a step further, stating that financial service providers might not be able to fully enlighten the client on all relevant details of a financial product. All the information provided would inevitably lead to information overload (Oehler and Kohlert 2009) and, as a result, reduce the quality of clients' decision-making capabilities. This paper focuses on consumer education during financial advisory services as well as its aforementioned difficulties to enable the client to understand the decisions at hand.

Amazingly, we see more than a decade of research on how people behave and decide in financial service encounters on the underlying problems of those settings. Although there are models to show why people behave in certain ways, a solution to improving financial decision making in service encounters is still missing. Insufficient *client knowledge* is the root cause of the problem because insufficient knowledge gives rise to principal-agent conflicts (Eisenhardt 1989), hinders "informed decision making" (Jungermann 1999) and leads to buying unsuited products (Inderst and Ottaviani 2009). Many national and international studies (ANZ Bank 2008; Brown and Graf 2012; Chater et al. 2010; Chen and Volpe 1998; Volpe et al. 2002) have documented a disastrous level of financial literacy for both the average population and active investors. Financially literate people, however, are in a better position to make good decisions (Chen and Volpe 1998).

Despite the problems described before, financial products are sold daily. Financial service providers have indeed found a way of working around these obstacles. According to Jungermann and Belting (2004), insufficient decision capability is compensated by mutual trust, with both parties drifting into a role-play of "as-if" behavior: the client behaves "as-if" he has understood everything and the advisor behaves "as-if" she actually believes the client. As part of that "as-if play," very simplified presentations and drawings together with poor analogies are used whenever the client raises questions, or the "script" of the advisory process demands some form of explanation. If financial service providers are afraid of being legally sued, they can simply document the advisory session with the help of minutes (for example, mandatory in Germany since 2010), stating that the client has been fully informed about the associated product risks (Künzl 2012). Some financial advisory service providers even take a simpler approach and let the clients sign a legal disclaimer when they are buying products.

This paper proposes an alternative solution: For the first time, to the best of our knowledge, we demonstrate how IT-based learning modules can be designed in order to be used during the encounter "just in time." Just in time consumer education has been suggested as a superior form of consumer education in the financial sector for reasons of knowledge decaying over time (Fernandes et al. 2014). Further support is given by Chater et al. (2010): "An alternative policy approach might be to target very specific information - either related to financial literacy or decision-making literacy - at the point at which the consumer is making a decision."

The following hypothetical advisory scenario exemplifies the importance of a sufficient understanding of financial matters in order to make better informed decisions. The scenario is based on our own impression from prior field work. The explanations used in this scenario are based on information material provided by the bank:

Robert is 35 years old and works as a plumber. He lives a frugal live and thus has built up a significant amount of cash in his bank account. Robert has never invested his money in any financial product apart from his savings account. His advisor proposes an investment offer to him, triggered by the fact that his cash amount recently reached 200,000 USD. She suggests that Robert should visit his branch to talk with his bank representative. Robert is a risk-averse person, which the banker soon recognizes, and so she advises him to define an investment strategy of 90% bonds and 10% equities. The banker tells Robert that diversification in different asset classes is key to reducing the overall risk. Robert has a hard time understanding why having 10% risky equities will make his portfolio safer compared to a pure bond strategy. The banker uses analogies drawn from daily life: diversification is like a table with one leg broken but an extra one to support the weight. Robert remains puzzled and just trusts the banker. The banker tells Robert that the expected return with the proposed strategy is about 2% per annum, based on the data of the last 25 years, and that the volatility is expected to be 5%. To illustrate these figures, the banker shows Robert the expected portfolio development in the next 20 years, starting with a relative index of 100%. The graphic clearly illustrates the benefits of that strategy compared to a simple savings account. Based on these graphics and visual aids, Robert agrees, and they arrange an appointment in a week's time when the bank will offer Robert a concrete product and start implementing the advised strategy.

This short and rather stereotypic first time financial advisory scenario helps to highlight the problems that can arise when clients do not fully understand the aspects of the decisions to be made in today's financial advisory services. A client, in most cases not a financial expert himself, is often unable to understand the decision rationales because many complex financial concepts produce counter intuitive results. Even in the above-described simplistic case, it remains unclear what the given information really means to Robert. What, for example, does he really understand by the 2% expected return? Can he really expect to get an annual rate of 2%?

Thus, our solution objective is to raise the clients' understanding regarding financial concepts/operations that are relevant to the decision-at-hand. We address this objective by designing an IT-system to support consumer education directly within the service encounter itself. We opt for a design based on the didactic method of experiential learning (Kolb 1984). More specifically, we raise the following research question:

How can experiential learning environments be designed to foster efficient consumer education in financial advisory services?

Based on related work, we derive design principles that guide the construction of small and interactive learning modules (microworlds) to be used during the service encounter. We evaluate our designed system in a controlled setting where we compare the learning outcome when using our system with the learning outcome using pen and paper. In both cases, a financial expert from a large Swiss bank explains the topics to the participants using the two different methods described. We evaluated the system by assessing the participants' knowledge levels objectively as well as subjectively through questionnaires. We also questioned which method of explanation they would prefer. Based on the results, we suggest that such systems can foster the learning of financial concepts. However, there still seem to be cases where the system does not lead to an advantage. We will discuss these shortcomings as well as the overall implications later.

Related Work

This work relates to a stream of research that strives to overcome the asymmetric structures of traditional advisory services towards stronger client involvement. Novak (2009) has identified "information asymmetry" and the related principal-agent-conflict (Eisenhardt 1989) to be one of three core problems of interactive involvement of clients in advisory service encounters. Information asymmetries occur on both sides: The advisor has limited information on the client's problem space and the client has limited information of the solution space (Novak 2009). However, this article deals solely with one side of the information asymmetry, where the client has insufficient knowledge about the solution space. In relation to Novak (2009) and Eisenhardt (1989), this asymmetry regarding the solution space is a precondition for raising of the principal agent conflict, where the client cannot verify that the advisor is behaving correctly. This is problematic, as the client does not know whether or not the advisor also has other (conflicting) incentives and might thus strive for his own goals, resulting in giving bad advice.

Access to information is a precondition but not sufficient to successful development of knowledge (Davenport and Prusak 1998). This also has been researched in financial advisory service context: The mere provision of static context in the form of brochures, for example, has been demonstrated not to significantly change the knowledge levels of the clients (Chater et al. 2010). Nevertheless, carefully designed IT artifacts can provide transparent access to information in financial service encounters and thus decrease the information asymmetries (Nussbaumer et al. 2012). In order to transform information into knowledge, transparent access alone is not sufficient, as people have to engage in knowledge creating activities, such as questioning the given information with respect to its implications on decisions or actions (Davenport and Prusak 1998).

Mayer (1989) assumes that learning outcomes (gain in knowledge), and thus also the learner's performance, are defined by the cognitive processes in the learner's mind. These processes are, according to his model, influenced by: a) the *learning material* (learning content), b) the *instructional method* (the method, how something is taught, including tools and presentations) and c) the *learner's personal characteristics*. Mayer uses the model with a "[…] focus on explanative material […]" (Mayer 1989). This relates perfectly to the initially stated goal of explaining how financial constructs work with the help of explanatory materials, such as graphs, for visualization.

While Mayer's model is of a more generic nature, Kolb (1984) focuses on experiential learning. Taking a pure constructivist point of view, Kolb assumes that "knowledge results from a combination of grasping and transforming experience" (Kolb 1984) and defines a four-step model called "*Experiential Learning Theory* (ELT)." The four steps/components of this model are: *Active Experimentation*, *Concrete Experience*, *Reflexive Observation* and *Abstract Conceptualization*. By iterating all of these steps during a learning cycle, an individual's knowledge level will be raised.

One conceptualization to support the experiential learning activities with IT systems is Land and Hannafin's (1996) *Open Ended Learning Environment* (OELE). They model how learners develop their understanding with an OELE (Figure 1). The similarity to the steps in Kolb's ELT is evident: The first three steps of the ELT model are covered by the experimental "Action"-"Intention" block, the "Feedback and Perception" block and the interpretive part. When closely examined, there are two experiential cycles embedded in Land and Hannafin's (1996) model. First, there is the outer and larger cycle, where the experiment as a whole is to be experienced by the learner, and then follows the smaller inner loop of adjusting action, according to intention. This mechanism is called "*reflection-in-action*" and dates back to Schön (Land and Hannafin 1996; Schön 1983).

This feature of learning through reflection-in-action offers a very efficient access to causal relationships. If a learner systematically explores OELEs, unanticipated behavior of the system can "trigger the learners' reflective process" (Land and Hannafin 1996) and thus help to develop a better understanding. Reflection-in-action (hands on) also increases brain activation and learners' motivation (Klahr et al. 2007).

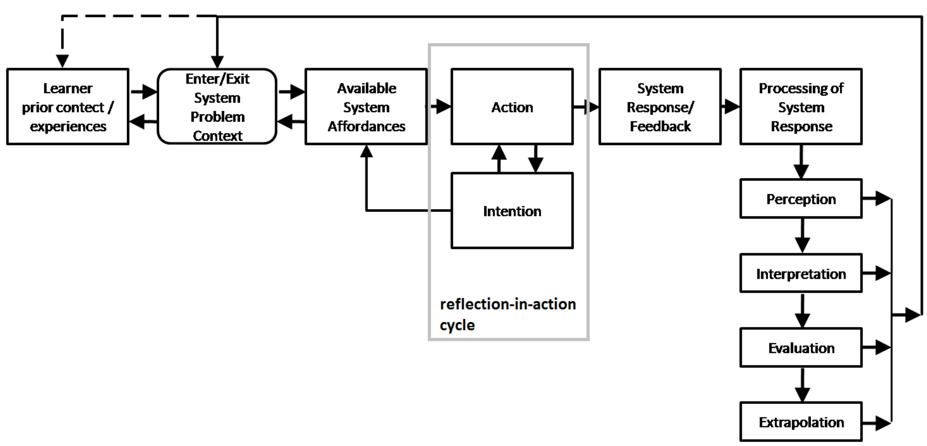

Figure 1: Model of theory development through OELE (Land and Hannafin 1996) with reflection-in-action cycle highlighted

Such interactive learning environments can be designed in various flavors, such as microworlds, simulations and games or as a mixture of them (Rieber 1996). The (serious) games have been applied to a variety of educational settings (groups vs. individuals) and in many domains such as Biology, Medicine, Engineering and Math (Wouters et al. 2013). A recent meta-study on the cognitive effects (Wouters et al. 2013) covered 38 studies where a serious educational game was directly compared to its traditional counterpart. That study showed that learning with serious games has a consistent and significant advantage, compared to traditional learning with a promising effect size (d=0.29). Furthermore, it was shown (Wouters et al. 2013) that supplementing serious games with additional instruction methods, as well as working in groups, had a positive moderating effect on learning outcomes.

With respect to decision making, IT-supported learning has already been used to assist in complex problem-solving situations (Yuan et al. 2013). In the context of finance, IT has been successfully applied in the form of simulated experiences to explain random distributions (Bradbury et al. 2013). Bradbury et al. have proved in their specific case that the educational method of simulated experiences have a positive influence on investment decision-making, compared to mere information provisioning. Thus, it has been demonstrated that explorative learning environments can have beneficial effects in financial service settings. However, these solutions are only designed for usage in single user learning sessions and not for use in collaborative face-to-face sessions. Also, generalizable design knowledge on how to construct such learning environments is missing. Hence, more research is necessary to find out "what designs work for whom under what conditions" (Frezzo et al. 2014). With this article, we contribute to this stream of research by presenting design rationales for a specific context and setting. We also contribute to the stream on financial service encounters, by presenting a practical approach to address insufficient client knowledge and its aforementioned associated problems.

Research Methodology

This research project followed the generic steps of Peffers et al. (2007) to conduct design science research in the IS field (Hevner et al. 2004). This paper reports on the three cycles of design science research *relevance cycle, design cycle and rigor cycle* (Hevner 2007). In the *relevance cycle* we derived the problems, provided basic solution objectives and gave arguments of why solving the problems is relevant to the described field for both practitioners and scholars. Through the *rigor cycle,* we grounded our design rationales within the identified set of kernel theories, domain concepts and empirical evidence. Hence, we followed a multi-grounded approach (Goldkuhl and Lind 2010) by applying these grounding strategies to our main conceptualization of design knowledge by using the widely accepted method (Gregor and Hevner 2013) of generic design principles (Van den Akker 1999).

The design ideas emerged before evaluation and governed the creation of the artifact. However, abstract design principles were formulated after the evaluation. This is anticipated, as the different viewpoints of ex ante and ex post evaluation (Pries-Heje et al. 2008) facilitate both induction and abstraction steps to extract design knowledge from DSR activities (Gregor et al. 2013). The design cycle activities instantiate the design principles in a prototype. The evaluation step demonstrates the usefulness of the artifact with respect to the stated objectives, thus providing empirical evidence for the design principles (Goldkuhl and Lind 2010).

Concretely, the design knowledge was crafted as follows: During the implementation of the prototype the researchers implemented 1) the knowledge in the system, relying on literature (see above), 2) background knowledge from previous design iterations (focusing on other issues of financial advice giving, not covering consumer education specifically) and 3) creative intuition. A first set of design principles was explicated directly after the end of the evaluation in January 2013. During the course of the next 15 months, we carved out the essential design knowledge in three subsequent versions of design principles (and in the first two versions: generic requirements). Each version was extensively discussed by the authors (in a group). We struggled to identify a minimal set of essential solution characteristics in the light of the problem and the kernel theories. A major issue we faced was identifying the appropriate level of abstraction in order that the design knowledge would be sufficiently general so it could be used in a wide area of applications, but still be sufficiently specific to be useful for a designer of a concrete solution.

Although the design knowledge was mostly explicated after the evaluation, we chose to present it before showing the evaluation results because the evaluation results can only be understood in the light of the design ideas. Refinements to our design ideas, emerging from observations made through the evaluation, are presented in the discussion section of the paper. Just presenting the prototype would be a poor proxy for presenting the design ideas.

The prototype was evaluated using experimental techniques. We derived the following working hypothesis from the solution objective: *Properly designed microworlds used within the advisory service encounter can outperform (from a knowledge acquisition perspective) traditional ways of providing paper–based explanations.* As the evaluation design is tightly connected to the data collection and the evaluation results, we will present it later.

Design Principles

The aim of this work is consumer education, more specifically, fostering the client's understanding of financial concepts/operations that are relevant to the decision-at-hand. This understanding can be furthered by applying the concept of OELE to the financial sector in the form of interactive microworlds. Microworlds are defined as "a small but complete subset of reality in which one can go to learn about a specific domain through personal discovery and exploration" (Rieber 1992). Through the interactive nature (users can alter the casual variables, giving input to the model) and the provision of fast feedback (simulation and output visualization of the effects), these systems can support the whole cycle of experiential knowledge acquisition. We assume that if learners are enabled to modify the financial model's independent variables (*causes*), they will quickly grasp: a) whether their influence (*effect*) is positive or negative and b) the size of the effect present. In contrast to providing static content (such as in a brochure or a wiki for example), knowledge is internally constructed through experiences with the help of simulations (possible conceptualization displayed in Figure 2). However, there is little time to accommodate the client to the system. Hence the learning environment has to be as intuitively understandable as possible in order to be used in practical settings.

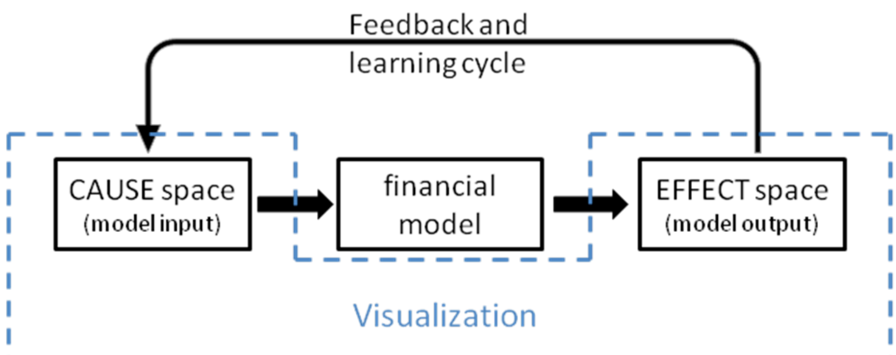

Figure 2: Cause space and effect space of financial model visualization

We argue that cause-effect relationships are most helpful when it comes to decision-making, as it helps to anticipate the outcomes of the decisions to be made. Furthermore, we argue that this kind of knowledge is hard to express in static forms of presentation (such as brochures or handwritten sketches). However, we are also aware that not all knowledge required by clients in order to fully understand their decisions can be solely expressed through cause-effect relationships. Therefore, we perceive our design solution to be a valuable extension of commonly used practices, rather than an all-embracing replacement.

We thus formulate our first design principle (DP):

DP1 "Enable experiences": *Represent all learning elements as simulated cause-effect relationships where the learner can alter the input (cause) and observe changes in the output (effect) in order to enable experiential learning.*

While learning can also happen (and probably will) outside the service encounter, this publication solely focuses on customer education during the encounter itself. However, service encounters are often very time-constrained. In the case of financial advisory services, the time the advisor spends with the client is often as low as 60 minutes (Oehler and Kohlert 2009). Therefore, if customer education is to happen within the encounter itself, it has to be fast and efficient in order to be of practical relevance. Therefore, we focus on enabling reflection-in-action cycles. Often financial models have continuous cause variables (for example, the ratio of a risky asset class in the portfolio) and continuous effects (such as expected risk or expected return). Reflection-in-action offers continuous and fast exploration of the relationship while changing causal inputs. Therefore, for all causal relationships within the model, the system should support *reflection-in-action*.

DP2 "Enable reflection-in-action": *Offer reflection-in-action for all learning episodes.*

Repetitive exploration of specific cause values and their effects are obviously tedious, requiring high mental effort to reveal the underlying relationship. Memorizing the value of a cause before the effect that can later be observed requires additional mental effort. Therefore, the change of causal data needs to be immediately followed by the resulting changes to the effect data in order that no additional memorizing is necessary. Thus, we formulate the first sub-principle of reflection-in-action:

DP2.1 "Immediate feedback": *Give prompt feedback (i.e., change effect visualization) to any changes of the cause variables in order to enable fast reflection-in-action cycles.*

Generally, humans are not good at visually grasping two different aspects changing simultaneously (here, causes and effects) - a limitation that can be deduced from the multi-tasking research (Anderson 2007). Anderson proposes that each sense is aligned with a separate mental resource. Although one can perform several tasks in parallel, one mental resource can only be used by a single task at a time (Anderson 2007). Hence, when two tasks have to be processed by one mental resource at the same time, one task will have to wait. This implies that true multitasking only works by applying different mental resources for different tasks. Thus, continuous input control with one resource (normally the tactile resource, e.g., controlling the hand driving the mouse or the finger sliding over a touch screen) as well as monitoring the effects using another resource (normally visual) is the best way to allow humans to directly observe and understand cause-effect relationships. A linear mapping of the tactile motion to the causal variable corresponds with the natural expectation of the users and thus helps to "blindly" control a causal input variable. Land (2000) states “visual cuing” to "emphasize critical variables" as one key implication on the design of OELEs, to switch the learner's attention from the causal manipulation towards the effect visualization. This leads to the second sub-principle of reflection-in-action:

DP2.2 “Allocate different mental resources”: *Use controls and visualizations that require different mental resources for inputs and outputs of the system in order to enable reflection-in-action cycles.*

We propose to spatially separate cause and effect space in order to provide visual guidance. The cause space contains all relevant tactile inputs to the simulation, whereas the effect space contains all relevant visualizations of the model output. When spatially separated, the learner can focus on the effect space with his visual resource while manipulating the inputs with his tactile resources. Therefore, we formulate the following design principle:

DP3 “Group cause and effect”: *Spatially group causal inputs and effect visualizations to the identical regions of all learning elements in order to enable intuitive interaction.*

Mapped to the advisory scenario, the system should be capable of running financial models with a subset of independent (cause) variables. When the client advances, more and more controls of variables can be added, if appropriate. This also provides the learner with control over the learning process. This is important because financial advisory services are flexible processes. Neither clients nor advisors accept systems that explicitly enforce process steps to be performed (Nussbaumer et al. 2012); rather, clients and advisors desire a free choice of functionality at any time at their discretion (Nussbaumer et al. 2012). However, the number of controls and effect-visualizations has to be limited to avoid overloading the visual resource. The literature suggests the well-known maximum number of about seven (Miller 1956). Therefore, we formulate the following design principle:

DP4 “Limit the input”: *Limit the number of causal variations in order to guide the learner towards the desired observation.*

In contrast to the previous three design principles, DP4 has to be handled with care, because there could be a potential tradeoff between accuracy of the model and its understandability. Reducing a complex model too far endangers its value of information; reducing it too little endangers its general understandability.

Design solution

We instantiated our design principles in the form of an IT-supported learning environment. Accordingly, we implemented two microworlds providing a simulation-based access to financial constructs (Figure 3 and Figure 4). These served as an extension to an existing prototypic IT-artifact system supporting financial advisory services.

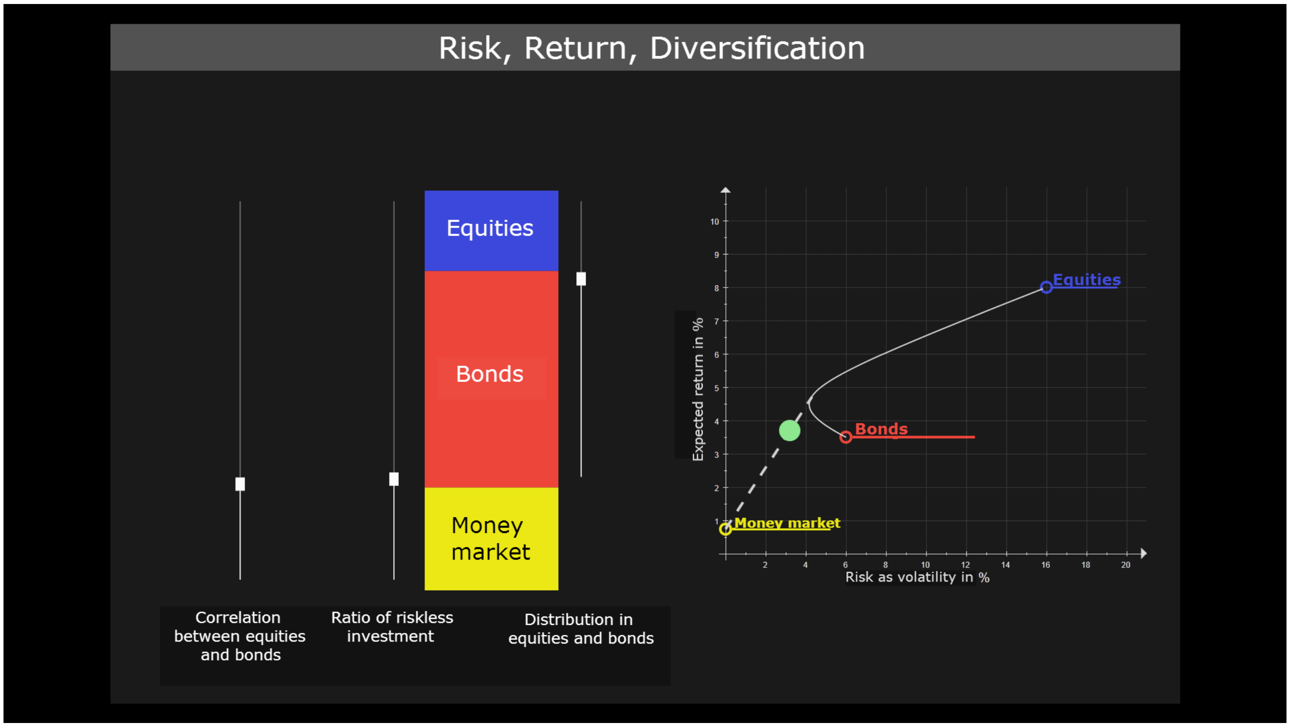

Figure 3: Learning environment for Portfolio Theory, Learning Unit 1 (LU1) (original screens in German language)

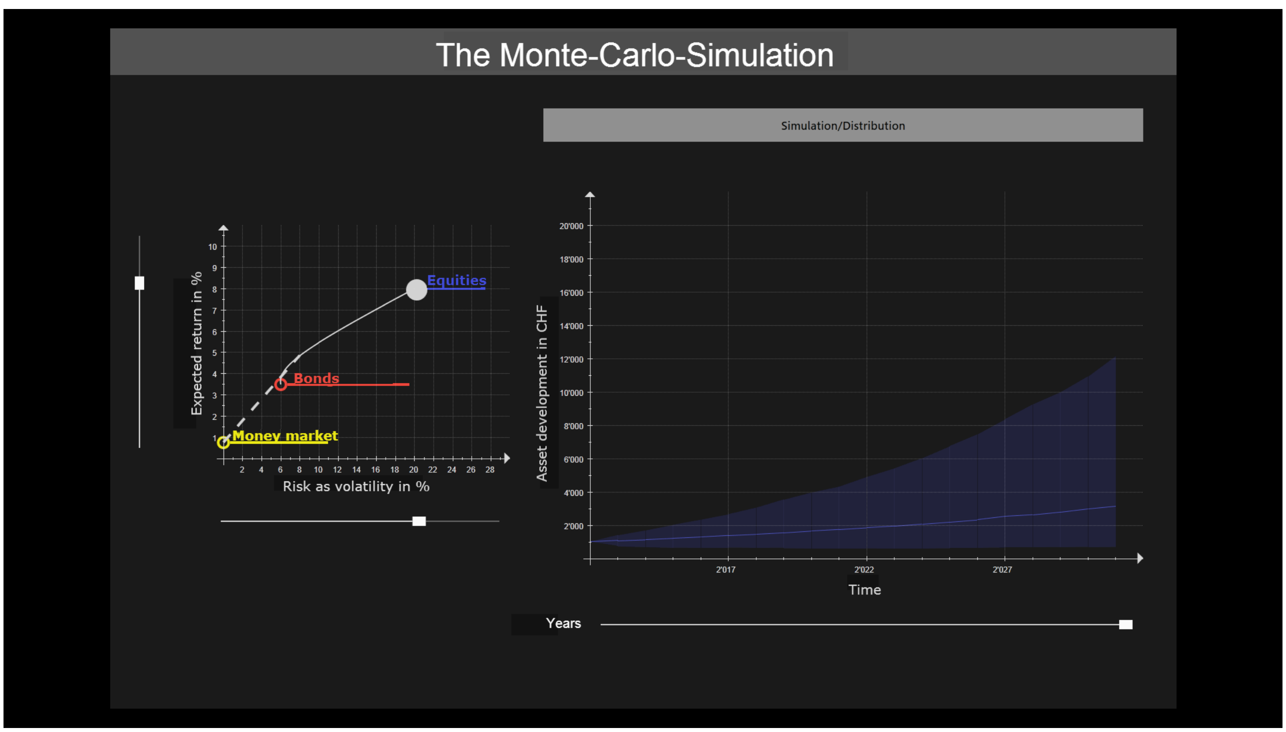

Figure 4: Learning environment for Monte-Carlo-Simulations, Learning Unit 2 (LU2) (original screens in German language)

While the existing prototypic system solely focuses on the advisory process itself with the design goal of making the service more transparent (Nussbaumer et al. 2012), our extension solely focuses on the learning aspect of financial models. We introduced two independent learning units LU1 and LU2. Both units use similar visualizations from the existing prototype to ease client's accommodation. Before explaining how the design principles are implemented in detail, the aim of this short activity scenario is to demonstrate the usage of our IT-artifact, as an example for one learning unit*:*

[...] Robert is a risk-averse person, as the banker soon recognizes, so she advises him to follow an investment strategy of 90% bonds and 10% equities. The banker tells Robert that diversification in different asset classes is key to reducing the overall risk. As the concept of diversification is new to Robert, the advisor immediately switches into the "learning mode." She presents Robert with an experimental environment where Robert can try different combinations of equities and bonds and where he is able to observe the effects of his manipulations to both risk and expected return. Soon, Robert discovers in the course of his interaction with the learning system that an optimal split between equities and bonds exists where the risk is minimized. The advisor also shows him that the effect is related to the independent performances of the two asset-classes (their correlation). Robert and the advisor experiment with different levels of correlation and Robert understands that the optimal ration between equities and bonds is independent of the correlation. As the advisor further explains that the market determines the independent performances of the asset classes, Robert is now convinced that the proposed split fits his needs of minimal risk best in any case. The advisor leaves the learning mode and continues with the normal course of the advisory process. [...]

FinanceWorlds was deployed on a large 40 inch multi-touch table (Microsoft SUR40). The basic idea behind using a multi-touch table was to create a shared workspace for both client and advisor, thereby reducing the obstacles of explicit control handover (Nussbaumer et al. 2012).

The first learning unit LU1 covers the Portfolio Theory (Markowitz 1952), simplified to a portfolio containing only three asset-classes with different risk profiles (equities, bonds and risk-free savings). This allows for examining the effect of diversification (Figure 3) (Weber 2007).

The learners can experiment with three independent variables of that model: 1.) Percentage of risk free assets as part of the total portfolio, 2.) Ratio of equity and bonds in the remaining part of the portfolio and 3.) Correlation between the prize of assets and the prize of bonds (to include crisis situations in the model). The effect on the risk-return curve is visualized on the right part of the screen in Figure 3. Such risk-return-diagrams are common in financial advisory services and thus known to the client either from previous experiences or from the ongoing advisory session.

The second learning unit, LU2, features the simulation of future wealth development (Monte-Carlo-Simulation) (Figure 4). This unit allows the learner to experiment with various portfolio properties (Figure 4 on the left) to learn about their impact on the future development of wealth (Figure 4 on the right). Three causal adjustments can be made in the corresponding space: The expected volatility, the expected return and the simulation duration (in years) can be changed independently by using three sliders. The effect space is visualized using a coordinate system, depicting the total wealth in relation to simulation time. The blue area in that coordinate system is the 90% percentile where the value of the portfolio is expected to reside.

For both LUs, the prototype implements the design principles in the following manner: Both learning units are designed as interactive simulations (DP1). The consumer can thus interact with the learning environment at any time. The causal controls are grouped in a cause-space on the left hand side and effect-space on the right hand side (DP3). For the manipulation of the causes, we used a restricted number of three sliders (DP4). People are used to operating sliders both in virtual and real worlds, and a precise input is not required for grasping the effects. The consumer can use one slider as analog input control metaphor with one hand and simultaneously observe the effect with his eyes (DP2.2). The prototype reacts instantly to slider movement with effect output (DP2.1). Therefore, repetitive explorations of cause values and their effects are supported (DP2). Every learning unit features only a single topic and the topic is covered entirely within a single screen.

Evaluation

In design science research, an evaluation measures achievement of the solution objectives (Peffers et al. 2007). In our case, the design goal was to improve customer education (learner performance) during the advisory service encounter. The improvement can be measured by comparing traditional paper based knowledge transfer with our microworlds-based method of knowledge transfer. We applied experimental techniques to implement this comparison. Before we go into the details of the experimental set-up, we will briefly introduce the evaluation model.

The evaluation is based on a simplified and adapted version of Mayer's (1989) model; the learner's performance serves as the dependent variable and the instructional method as the sole independent variable. We assume that the instructional method influences the learner's performance through changes in the cognitive processing (Figure 5).

Figure 5: Evaluation-model (simplified version of teaching/learning performance-model (Mayer 1989))

By varying the instructional method from paper-based descriptions to microworlds-based exploration, we enable fast reflection-in-action cycles, increase the learner activation and motivation, as well as decrease cognitive switching, as explained in section *Related work* and *Design Principles*. We propose that these increases/decreases lead to more, or more effective, cognitive processing by the client, and thus will improve learner performance. As typical in exploratory design science research, we only evaluate bundles of independent factors tied together by one artifact instantiation. We therefore do not propose hypotheses on the individual factors, such as the effect of isolated design principles. We rather propose that the described changes in all instructional method characteristics lead to an increase in cognitive processing and a subsequent increase in learner performance.

Evaluation of the learning environment was embedded within a complete service encounter to retain a realistic setting. The financial advisory service encounter itself was supported by IT throughout the entire time and included the following typical steps: Smalltalk, understanding of client's financial situation, risk perception and future financial goals before seamlessly diverting to the learning treatments. Details on this IT-support-system without the learning modules, can be found in prior publications (Nussbaumer et al. 2012) of our research group. During the encounter, each subject received two training episodes: a traditional pen and paper explanation on one learning task and an explanation with the prototypic system on another learning task. Thus, the clients were able to compare both treatments and we could test each learner's performance on both treatments. Both learning tasks on LU1 and LU2 were prepared for both instructional methods. We randomized the order of instructional methods.

We expected that the learning success would be strongly related to the financial advisor's performance. To avoid this bias, two measures were taken: First, all explanations were provided by the same financial expert from a major Swiss bank who had not been involved previously in the research. Second, to ensure that all participants received the same treatment with the same quality of explanations, the expert was recorded on video and this video was used to instruct each participant during the encounter.

The explanation of each learning unit (LU) was simultaneously recorded from two perspectives: First, we filmed the advisor from above in order to capture the writings and drawings he did on pen and paper or the manipulations when working with FinanceWorlds. Second, we filmed him upfront in order to capture his facial expression during the explanations. Figure 6 shows the final setting for the subjects, demonstrating both instructional methods. For each LU, we first recorded the financial advisor using pen and paper, before we introduced him to our system, as we did not want to influence his method of explanation. In the pen and paper recording, he started with a stack of empty A4 paper sheets and consecutively wrote on the papers during his explanations. For the IT-supported recordings, the camera positioning was the same, but the table was replaced by the multi-touch tabletop running the FinanceWorlds environment. Two experienced researchers provided the foregoing advisory sessions. To exclude a systematic influence of this advisory session, the combination of learning tasks and instructional method was only randomly selected after the foregoing financial advisory session was completed.

For the recording of the learning units, we could not control for the length of the financial advisor's explanations because we did not want to give him a detailed script telling him when to do what. Our aim was to let the expert explain as "natural" a manner as possible; he decided how to explain the contents of the learning units and how extensive his explanations would be. In fact, the duration for the first learning unit just differed by 23 seconds and the second learning unit differed by 115 seconds (see Table 1) concerning the instructional method.

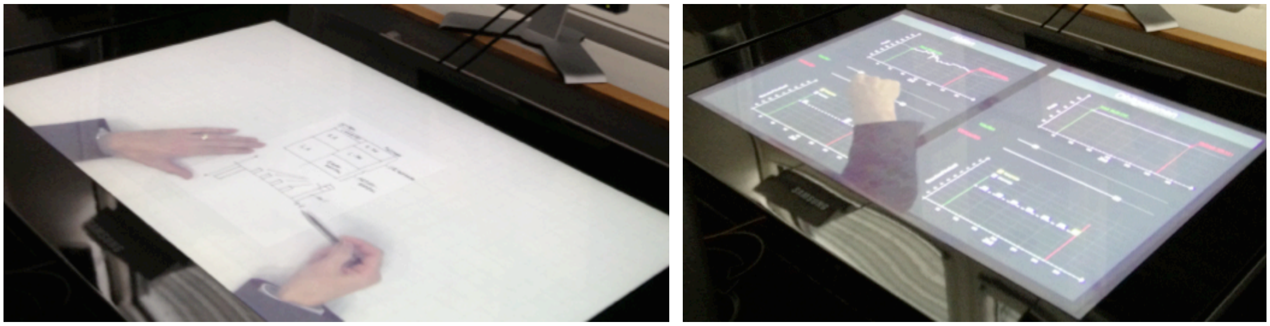

Figure 6: Video stills of the two treatments (*left*: traditional desk with pen and paper; *right*: IT-supported learning environment).

	Pen & Paper	IT-Supported
Learning unit 1	11:11 [s]	11:34 [s] (incl. 2x90s active experimentation)
Learning unit 2	10:31 [s]	12:26 [s] (incl. 2x90s active experimentation)

Table 1: Timing information for treatments

The paper and pen sessions exclusively consisted of explanations by the advisor. In the IT-supported treatment, the subjects were also encouraged to interact with the system themselves for 180 seconds (in two 90 seconds episodes).

The experimental subjects were third year bachelor students[1]. We had to assume that some of them had taken a university course with investment related topics. We therefore had to increase the difficulty of the learning tasks compared to the 'normal' financial service advisory audience. However, the topics covered are identical to those discussed in real life investment advisory service. Paper versions of the two visualizations, Risk-Return-Charts and the Monte-Carlo-Simulation, are used by a major Swiss bank in their advisory service encounters on a regular basis.

A questionnaire was applied to assess the learners' performance (see appendix). It consisted of statements the subjects could answer with 'correct,' 'incorrect' or 'I do not know.' For the evaluation, we counted the number of correct answers only. The questionnaire was based on two sources. For LU1, we consulted an introductory book for people interested in financial investments (Weber 2007), with a focus on the topic of portfolio theory. For LU2, we used a textbook on Portfolio management (Spremann 2002).

In addition to the objective post treatment knowledge, we also assessed the influence on the perceived knowledge. We used Flynn and Goldsmith's instrument (Flynn and Goldsmith 1999) for this purpose. Consisting of five items measured on a Five-Point Likert scale (strongly agree – strongly disagree), the

[1]plus one student who had graduated a few weeks before the experiment as a replacement for a short notice drop-out subject

questionnaire asked the participants to rate their perceived knowledge level with reference to that of their peers and other people in general.

In addition to the assessment of knowledge level, participants were asked which instructional method they preferred.

For all measurements, we treated the video-explanation using traditional pen and paper method as the baseline reading. These pen and paper based explanations resemble today's work practices within our controlled environment.

Evaluation Results

The 38 participants were all students from a Bachelor Business Informatics course (with the exception of one doctoral student), four of which were female students. Of the original 38 participants, 37 were included in the analysis. One participant was removed because he refused to complete the questionnaire. The participants were approximately 24 years of age (m=23.97, s=3.3, min=20, max=40). Six had prior experience with investment advisory, but only two had actually received professional financial advice themselves. Thirteen of the participants stated that they had taken a university course where the topic of investments had been discussed previously.

Participants in our sample using the FinanceWorlds protoype gave 61% correct answers, compared to 46% correct answers of those instructed with the pen and paper method. The difference of 15% is highly significant (two-sided paired t-test, $T(36)=4.38$, $p<0.001$).

However, when splitting the results into the separate learning episodes, only the candidates that used the Microworld for LU1 did profit from the method (Figure 8): They gave over 76% correct answers, compared to 44% of the pen and paper treatment. Using either the microworlds or the conventional pen and paper based situation for LU2 did not make any difference (both treatments reached 48% of correctly given answers).

During the microworlds phases of the evaluation we could observe different interaction patterns in LU1 and LU2. In LU1, most of the participants accomplished the intended focus switch from cause- to effect-space. In LU2, the subjects mostly kept their focus on the cause space, trying to adjust their input to concrete values instead of exploring the effects of their manipulations regarding the financial model.

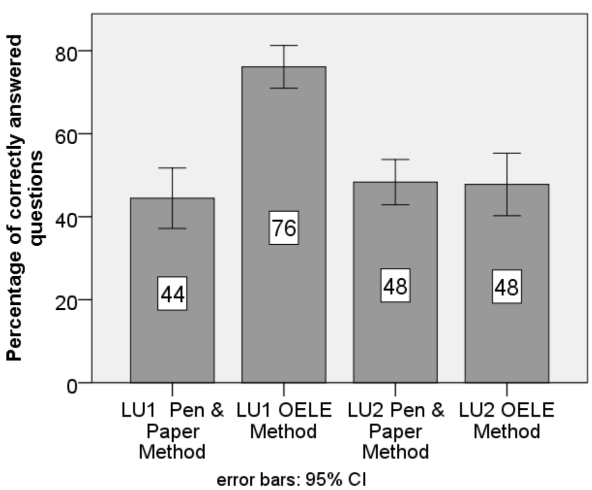

Figure 7: Overall objective knowledge results for both methods

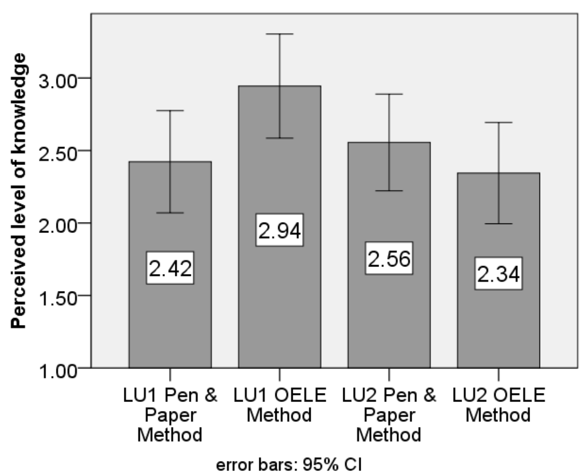

Figure 8: Subjective knowledge results for both methods and learning episodes (five-point Likert scale)

The results of the perceived subjective knowledge are displayed in Figure 8. Again, only participants using the microworld for LU1 could profit from the method. They rated their perceived knowledge 0.52 points higher using the microworld compared to the traditional setting on a five-point Likert scale. The result is significant (two-sided unpaired t-test, $T(35)=2.209$, $p<0.05$). For LU2, the participants felt even slightly less knowledgeable when using the system but the difference was not significant.

Over all, the test participants preferred the FinanceWorlds based approach over the traditional pen and paper method. On a seven-point Likert scale, eight people preferred the traditional method, five people were indifferent and 24 people preferred the OELE. The preference for the new system was significant ($m=4.92$, $s=1.83$, one sample t-test, test value 4, $T(36)=3.05$, $p<0.005$). Participants who used the microworlds for LU1 rated the preference towards IT-supported learning much higher ($m=5.56$, $s=1.79$; one sample t-test, test value 4, $T(17)=3.69$, $p<0.005$) compared to participants who used the microworlds for LU2 ($m=4.32$, $s=1.70$, one sample t-test, test value 4, $T(18)=0.81$, $p=0.43$).

Discussion and Conclusion

The results of LU1 suggest that properly designed microworlds can foster learning in a financial advisory setting. The experimental subjects had more financial knowledge after an experiential learning episode (supported by our FinanceWorlds prototype) than after a traditional paper based explanation. We attribute these improved results not only to an increase of the client's applicable cognitive capacity, but also to the learner activation. We assume that the following microworld characteristics contribute to these changes: the applicable cognitive capacity is increased by making use of additional senses and by using the brain's capability to link changes in causes and effects if they are presented simultaneously. The learner is activated by engaging in reflection-in-action cycles. Using the client's personal life situation as starting point, we aim to increase his motivation; however, more research on this aspect is needed. The integration of the learning environment into the advisory system arguably decreases cognitive switching costs, as the client has a solid pre-knowledge of the relevant financial models and the microworld's user interface.

In order to reap the benefits, users have to open their minds to learning approaches other than traditional lecture style teaching. Experiential learning turns out to be a useful approach to engage clients and to transfer fundamental financial knowledge to them, even if only a limited amount of time is available.

Why can advisors not use the operational financial advisory system for experiential learning? Our study identifies a set of subtle but important design differences that can be traced back to the different goals. While a valid goal of an operational advisory system might be decision making and *information* transparency (Nussbaumer et al. 2012), the goal of the microworld enriched system is knowledge acquisition. While the operational system can be (and in fact is) used most of the time by the advisor, experiential learning requires the microworlds to be operated by the client. As clients get advice only in very infrequent intervals, the embedded microworlds must be very intuitive and less complex than the operational system. The small and self-contained nature of microworlds allows the client to easily take over control in infrequent intervals. These microworlds run in a protected mode in several senses: The learning modules are visually isolated from the rest of the system. Furthermore, the system assures that no real data are changed while the clients interact with the learning environment.

On the other hand, the simulation-based approach provides a more dynamic interface by offering continuous data input (through sliders) instead of discrete but precise number input (i.e., through text boxes). However, the real client's data could also be used as a starting point for the exploration. Here, the similarity of the interface and the applied models assure small switching costs between advice giving and learning.

Without our prior intention, the results also show how carefully a system must be designed if it really wants to reap the potential benefits. For LU1, the system followed the guidelines, and we could subsequently observe a highly significant increase of learner performance. In LU2, that did not seem to happen, although it was designed following most of the same guidelines. We provide two tentative explanations for this. First, while using the same input metaphor, we did observe that the subjects stuck to the cause-space and thus did not have the intended experiences. We assume that by confronting the learners with simultaneous visualizations in the cause and effect space (Figure 4), we overloaded their visual channel and thus observed typical multitasking problems. One other possible explanation is that the effects of the cause variables of LU2 were not independent of each other. Some cause variables had a moderating effect, that is, some of the effects could only be observed under certain conditions. Further research is needed on those observation.

However, we conclude that careful attention should be paid to the design of the learning environment. Guiding the visual attention of the learners is key to ensure that they can make the intended experiences and engage in reflection-in-action cycles while interacting with the microworlds. To achieve this, the arrangement of causal input and effect visualization has to be combined with appropriate input control to fully utilize the learner's resources through a variety of channels.

This paper offers typical design science contributions: design guidelines on a novel system type as well as in their prototypical instantiation. Requirements and guidelines primarily inform the design efforts of developers of financial advisory systems. We are confident that the results can also be applied to other settings involving advice giving using simulations (e.g., insurances, tax advice, etc.). Secondary benefits can be reaped by clients and advisors using the novel system or banks hosting the advice-sessions: With our solution, the client can gain knowledge specifically tailored for his personal life situation and thus he is better able to understand problems and offered solutions. Clients could not achieve this individually before the advisory session, as their relevant topics and knowledge gaps were unclear or unidentified at that time. Educating clients also helps to shift the decision process more towards the clients (Jungermann 1999) and thus engaging them in a value co-creation process (Prahalad and Ramaswamy 2004).

Fostering informed decision making (Gafni et al. 1998) is assumed to result in a higher decision quality, an implication that financial service providers could also profit from in terms of customer satisfaction and retention. Using our system, financial advisors could also assess the client's knowledge and thus comply with the regulations (WpHG 2011).

We furthermore synthesized design rationales in the form of generalized design principles. Therefore, it can be applied in many dyadic expert-layperson learning scenarios, such as doctor-patient interactions or value co-creation activities in travel counseling. Consequently, we see a potential for microworld based consumer education to significantly change the client-advisor relationship and the advisory experience in many domains.

Limitations

The applied research methodology not only has strengths but also some limitations: We see strengths in the controlled experimental set-up. The explanations, given by a top financial expert from a major Swiss bank, were consistently presented to the subjects using video recordings. Limitations largely result from the design science research background: We cannot attribute the successful application of the novel system to individual factors such as design principles, as we tested them in a bundle. Furthermore, we used students as client subjects. We had to adapt the learning task to their higher learning capability. The low number of test subjects limits the generalizability of the results. Further research needs to control for individual characteristics and extend the domain of IT-supported consumer education to deepen our understanding of the design rationales.

Appendix

Learning Episode 1	Learning Episode 2
1. The price of shares is subject to gains and losses of the company. 2. The total interest profit on bonds is paid at the end. 3. With sufficient liquidity of a company, there is still a risk of loss at the end of the term of bonds. 4. The interest income from bonds is usually above the market profit. 5. Equities already generate profit during the investment period. (excluding dividends). 6. The price fluctuations of equities are usually smaller than those of bonds. 7. In normal market conditions, the correlation between equities and bonds is low. 8. A negative correlation between equities and bonds is categorically impossible. 9. The effect of diversification is especially strong if the asset classes are positively correlated. 10. With decreasing correlation the expected risk also decreases; however, the expected return is the same.	1. It is assumed that the simple annual return is normally distributed, which means that it is equally likely to lie above or below the expected value. 2. For a skew-symmetric distribution, the mean and mode are approximately the same. 3. The expected value of the portfolio is the value that is most likely reached. 4. Mode, median and expected value are closer together, the higher the expected risk is. 5. It is a priori more likely that the assets of an investor will develop below the median and mean of all simulations. 6. The value of the portfolio is at the end of the simulation (t> 1 year) normally distributed. 7. An increasing expected return (at t>1 year) only shifts the distribution; the shape of the distribution remains constant. 8. The simulation can also be explained by "Brownian" movements, i.e., each simulation with the same parameters leads to a different result. 9. The median line in the Monte Carlo simulation shifts with increasing risk downside. 10. The median line in the Monte-Carlo simulation is not linear with time.

Table 2: Yes-No questions to assess the knowledge level of the participants.

References

Van den Akker, J. 1999. "Principles and methods of development research," in *Design approaches and tools in education and training*, Springer, pp. 1–14.

Anderson, J. R. 2007. *How can the human mind occur in the physical universe?*, Oxford University Press, USA.

ANZ Bank. 2008. *ANZ Survey of Adult Financial Literacy in Australia*.

Bradbury, M., Hens, T., and Zeisberger, S. 2013. "Improving Investment Decisions with Simulated Experience," *Available at SSRN 2179276*.

Brown, M., and Graf, R. 2012. *Financial Literacy, Household Investment and Household Debt: Evidence from Switzerland*, Working Papers on Finance 1301 (2012).

Chater, N., Huck, S., and Inderst, R. 2010. "Consumer decision-making in retail investment services: a behavioural economics perspective," *Final Report* (22).

Chen, H., and Volpe, R. P. 1998. "An analysis of personal financial literacy among college students," Financial Services Review, Greenwich (7), pp. 107–128.

Davenport, T. H., and Prusak, L. 1998. *Working Knowledge: How Organizations Manage what They Know*, Harvard Business Press.

Eisenhardt, K. M. 1989. "Agency theory: An assessment and review," *Academy of management review* , pp. 57–74.

Fernandes, D., Lynch, J. G., and Netemeyer, R. G. 2014. "Financial Literacy, Financial Education, and Downstream Financial Behaviors," *Management Science*.

Flynn, L. R., and Goldsmith, R. E. 1999. "A Short, Reliable Measure of Subjective Knowledge," *Journal of Business Research* (46:1), pp. 57–66.

Frezzo, D. C., DiCerbo, K. E., Behrens, J. T., and Chen, M. 2014. "An extensible micro-world for learning in the data networking professions," *Information Sciences* Serious Games, (264), pp. 91–103.

Gafni, A., Charles, C., and Whelan, T. 1998. "The physician–patient encounter: The physician as a perfect agent for the patient versus the informed treatment decision-making model," *Social Science & Medicine* (47:3), pp. 347–354.

Goldkuhl, G., and Lind, M. 2010. "A multi-grounded design research process," *Global Perspectives on Design Science Research* , pp. 45–60.

Gregor, S., and Hevner, A. 2013. "Positioning and Presenting Design Science Research for Maximum Impact," *Management Information Systems Quarterly* (37:2), pp. 337–355.

Gregor, S., Müller, O., and Seidel, S. 2013. "Reflection, Abstraction And Theorizing In Design And Development Research," *ECIS 2013 Completed Research*.

Hevner, A. R. 2007. "The three cycle view of design science research," *Scandinavian journal of information systems* (19:2), p. 87.

Hevner, A. R., March, S. T., Park, J., and Ram, S. 2004. "Design Science in Information Systems Research," *MIS Quarterly* (28:1), pp. 75–105.

Inderst, R., and Ottaviani, M. 2009. "Misselling through Agents," *The American Economic Review* (99:3), pp. 883–908.

Jungermann, H. 1999. "Advice giving and taking," in *Proceedings of the 32nd Annual Hawaii International Conference on Systems Sciences, 1999. HICSS-32*, p. 11 .

Jungermann, H., and Belting, J. 2004. "Interaktion des als ob: Privatanleger und Anlageberater," *Gruppendynamik und Organisationsberatung* (35:3), pp. 239–257.

Klahr, D., Triona, L. M., and Williams, C. 2007. "Hands on what? The relative effectiveness of physical versus virtual materials in an engineering design project by middle school children," *Journal of Research in Science Teaching* (44:1), pp. 183–203.

Kohlert, D., and Oehler, A. 2009. "Scheitern Finanzdienstleistungen am Verbraucher?: Eine theoretische Analyse rationalen Verbraucherverhaltens im Rahmen des Anlageberatungsprozesses," *Quarterly Journal of Economic Research* (78:3), pp. 81–95.

Kolb, D. A. 1984. *Experiential learning: Experience as the source of learning and development*, (Vol. 1) Prentice-Hall Englewood Cliffs, NJ.

Künzl, M. 2012. "Beratung / Entwicklung," in *EINFACH mehr Umsatz*, Gabler Verlag, pp. 87–110.

Land, S. M. 2000. "Cognitive Requirements for Learning with Open-Ended Learning Environments," *Educational Technology Research and Development* (48:3), pp. 61–78.

Land, S. M., and Hannafin, M. J. 1996. "A Conceptual Framework for the Development of Theories-in-Action with Open-Ended Learning Environments," *Educational Technology Research and Development* (44:3), pp. 37–53.

Markowitz, H. 1952. "Portfolio Selection," *Journal of Finance* (7:1), pp. 77–91.

Mayer, R. E. 1989. "Models for Understanding, " *Review of Educational Research* (59:1), pp. 43–64.

Miller, G. 1956. "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological review (63:2)*, pp. 81-97.

Novak, J. 2009. "Mine, yours... ours? Designing for principal-agent collaboration in interactive value creation," *Wirtschaftsinformatik Proceedings 2009. Paper 23.*

Nussbaumer, P., Matter, I., and Schwabe, G. 2012. "'Enforced' vs. 'Casual' Transparency–Findings from IT-Supported Financial Advisory Encounters," *ACM Transactions on Management Information Systems (TMIS)* (3:2), p. 11.

Oehler, A., and Höfer, A. 2012. "Die Verbraucherwirklichkeit: Mehr als 50 Milliarden Euro Schäden jährlich bei Altersvorsorge und Verbraucherfinanzen. Befunde, Handlungsempfehlungen und Lösungsmöglichkeiten," (available at: https://www.uni-bamberg.de/fileadmin/uni/fakultaeten/sowi_lehrstuehle/finanzwirtschaft/Transfer/20122012x__Milliardenschaeden_bei_Altersvorsorge_und_Verbr....pdf).

Oehler, A., and Kohlert, D. 2009. "Financial Advice Giving and Taking—Where are the Market's Self-healing Powers and a Functioning Legal Framework When We Need Them?," *Journal of Consumer Policy* (32:2), pp. 91–116.

Peffers, K., Tuunanen, T., Rothenberger, M. A., and Chatterjee, S. 2007. "A design science research methodology for information systems research," *Journal of Management Information Systems* (24:3), pp. 45–77.

Prahalad, C. K., and Ramaswamy, V. 2004. "Co-creating unique value with customers," *Strategy & Leadership* (32:3), pp. 4–9.

Pries-Heje, J., Baskerville, R., and Venable, J. 2008. "Strategies for Design Science Research Evaluation," *ECIS 2008 Proceedings*.

Rieber, L. P. 1992. "Computer-Based Microworlds: A Bridge between Constructivism and Direct Instruction," *Educational Technology Research and Development* (40:1), pp. 93–106.

Rieber, L. P. 1996. "Seriously Considering Play: Designing Interactive Learning Environments Based on the Blending of Microworlds, Simulations, and Games," *Educational Technology Research and Development* (44:2), pp. 43–58.

Schön, D. A. 1983. "The reflective practitioner: How professionals think in action," (Vol. 5126) Basic books.

Schwabe, G., and Mogicato, R. 2009. "Beratungsqualität in Banken. Was der Kunde erwartet. Was der Kunde erlebt," *Solution Providers AG.*

Spremann, K. 2002. *Portfoliomanagement*, Oldenbourg Wissenschaftsverlag.

Volpe, R. P., Kotel, J. E., and Chen, H. 2002. "A survey of investment literacy among online investors," *Financial Counseling and Planning* (13:1), pp. 1–13.

Weber, M. 2007. "*Genial einfach investieren: Mehr müssen Sie nicht wissen - das aber unbedingt!*, " Campus Verlag.

Wouters, P., van Nimwegen, C., van Oostendorp, H., and van der Spek, E. D. 2013. "A meta-analysis of the cognitive and motivational effects of serious games," *Journal of Educational Psychology* (105:2), p. 249.

WpHG. 2011. "Wertpapierhandelsgesetz in der Fassung der Bekanntmachung vom 9. September 1998 (BGBl. I S. 2708), Gesetzes vom 22. Dezember 2011 (BGBl. I S. 3044)".

Yuan, B., Wang, M., Kushniruk, A., and Peng, J. 2013. "Technology-Enhanced Learning for Improving Complex Problem-Solving Expertise," in *Advanced Learning Technologies (ICALT), 2013 IEEE 13th International Conference on*, IEEE, pp. 379–381.