Rapid Prototyping Instructional Design: Revisiting the ISD Model

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An exploratory investigation, utilizing mixed methods, was used to examine the quality and usability of the product and the client's role within a rapid prototyping instructional design approach. Forty engineering and business undergraduates participating in a leadership training session and an instructional design team comprised the sample for this study. Findings support that the rapid prototyping process results in a high quality and usable product, and a successful relationship with the client.

Keywords: Rapid Prototyping, Training and Development, Instructional Design

Problem Statement

In a fast-paced, knowledge-based world, with intangible assets playing a more dominant role (Kaplan & Norton, 2001), efforts aiming at improving both efficiency and effectiveness of processes are truly welcome and tend to be well rewarded when driving performance. The field of Human Resource Development (HRD) with the dimensions of training and development, career development, and organizational development deals with domains of learning and performance within organizational settings, focusing on "adult human beings functioning in productive systems" (Swanson & Holton, 2001, p. 3). Thus HRD has the credentials to contribute with solutions for improving both efficiency and effectiveness.

Organizational settings must tackle ever-increasing challenges from external and internal environments that may be converted into specific demands for an improved set of knowledge, skills, and attitudes from the individual to the organizational level. Thus, the ability to sense and anticipate such needs is crucial in a fast-paced, ever changing environment, to the overall performance of individuals and organizations. A key issue is that, as in other systems design contexts (e.g., software) time is a very scarce and valued resource when discussing instructional design. In particular, the process of designing a new system is truly anchored on time, knowledge, and people. Beyond meeting the demands of time, the resulting design must conform to other demands such as quality standards and user needs. An efficient design does not necessarily translate into a quality, usable product or process. These concerns must also be addressed when discussing efficiency within the context of instructional design.

Alternative ways of moving through the training and developing process may be considered depending on an appropriate match between resources and needs within a particular context. A foundational model of this process is the ADDIE model, involving the steps of analysis, design, development, implementation, and evaluation (Rothwell & Kazanas, 2004; Swanson & Holton, 2001). A wide range of factors (e.g., training recipients, content, delivery, time-frame, objectives, instructor, and artifacts) impact the amount of time and effort involved in each phase. Based on the need for a time-responsive and cost-effective approach to the system design process, rapid prototyping has been offered as a basis for alleviating the demand for a more efficient use of resources within the instructional system design process. Rapid prototyping (RP) "involves the development of a working model of an instructional product that is used early in a project to assist in the analysis, design, development, and evaluation of an instructional innovation" (Jones & Richey, 2000, p. 63). Essentially, RP's roots are embedded in the ADDIE model however this approach is intended to reduce the time and cost associated with a full-implementation of the instructional system design (ISD) model.

RP is an established efficient approach to ISD, however little empirical research has focused on other important issues related to its effectiveness in developing the final product and the role of the client. In today's fast-changing world, HRD must be able to, not only respond efficiently, but effectively to ever-emerging demands. Within the realm of ISD, there potentially exists a trade-off between efficiency and effectiveness, mainly when approaching the design phases with a different pace. Specific design elements of the RP approach, including product quality, client

involvement, and the usability and customization of the product, need further investigation to support its continued use as a vital component of ISD. This information should be beneficial to the HRD practitioner, who is facing these demands and needing innovative, efficient and high quality approaches and solutions. In determining RP's usefulness to the HRD practitioner, beyond offering an efficient approach, these other design elements require exploration and documentation.

Purpose and Goal

Propelled by the aforementioned problem related to the approach of rapid prototyping to instructional design, this study analyzes the quality of the product, client involvement, and the usability and customization of the product through a variety of measures. The potential trade-off between efficiency and effectiveness is addressed through the measures of product quality and usability, along with client involvement. The quality dimension is connected to maximizing the utility of the training package to the users (individuals and groups that will directly or indirectly receive its benefits). The usability dimension is connected to the delivery and reception of the training from the facilitator and recipients' points of view. Client involvement was an important measure due to the fact that the RP process requires a high level of participation from the client, who often serves many roles in the process. Although this level of involvement may be seen as a drawback of this approach, this study found numerous benefits attributable to the level of client involvement.

Theoretical framework

Criticisms of Traditional ISD models

The discipline of instructional design is based primarily on two components: (1) a systems approach to design and (2) theories on effective instruction (Wilson, Jonassen, & Cole, 1993). Instructional systems design (ISD) is intended to be responsive to many factors including the environment, the learners' and clients' needs, goals and objectives, etc. The proliferation of ISD models have resulted in a variety of approaches intended to translate the process of instructional design into a flexible, useful, and discriminating process (Edmonds, Branch, & Mukherjee, 1994). Traditional ISD approaches however have been found to be difficult to apply in practice in both corporate and school-based settings (Moallem, 1998; Tessmer & Wedman, 1992). Critics argue that traditional approaches are too linear, requiring a rigid, step-by-step process that is too formal and inflexible. In addition, the process has been argued to be too slow and overly analytical (Zemke & Rossett, 2002). ISD approaches are also not one-size-fits all; what works in a classroom setting may not translate into a workplace setting (Davenport, 2006).

Rapid Prototyping Defined

Rapid prototyping has been offered as a remedy to some of these criticisms. RP is intended to reduce the time and cost of a traditional ISD approach, while increasing the flexibility and client involvement. RP also hinges on an iterative, overlapping approach to design, instead of a linear approach, through the ADDIE phases. Focusing on these dimensions of the process, Piskurich (2000) presents RP as "a continuing process, with new aspects being added and evaluated in this mode each week until you finally have the complete program" (p. 242). RP developed primarily within the setting of computer-based products but has increasingly been used in designing paper-based training solutions. RP, as an instructional design process, strives to realize the actual structure of the design with a prototype as early in the process as possible to reduce the time and expense of a full development cycle. RP has been interpreted by some as merely being a type of formative evaluation. However, others see it as a distinct approach to design that is more useful in the fast-pace climate of today. Tripp and Bichelmeyer (1990) even argued that RP represents a "paradigm shift in understanding the nature and purpose of the field of instructional design" (p. 40).

Prototypes or workable models are "simply shells that demonstrate the projected appearance of the product" (Jones & Richey, 2000, p. 64). In addition to appearance, key elements of the final product are incorporated but are typically incomplete. Prototypes may be shallow or narrow. Shallow prototypes reveal the entire look of a product minus some functionality of its components and narrow prototypes reveal a small segment of the product, but that segment is fully functionality (Wilson, Jonassen, & Cole, 1993). In some instances, the prototype is discarded in favor of a new prototype and in other instances it evolves into the final product. Those that evolve into a final product are referred to as executable prototypes. According to Jones, Zhongmin, and Merrill (1992), the primary difference between a traditional ISD approach and rapid prototyping approach of "Second Generation Instructional Design Research Program" tool ID2, is the "difference between early constraint of design decisions and a philosophy of limited commitment to the components of an evolving design" (p. 99).

RP Models

Many RP models have been proposed, tending to conform around the ADDIE model (analyze, design, develop, implement, and evaluate). However RP models tend to emphasize pre-design analysis, design and development and formative evaluation over summative evaluation. In addition, RP models are intended to illustrate an iterative process to design where the analysis of needs and content occurs in conjunction with the building and testing of a prototype of the instruction. For example, Yang's 1995 three-dimensional model was developed for use in computer-based courseware. This model focuses on three traditional stages: (a) analysis, (b) development, and (c) evaluation, along with a software-engineering based template for managing production activities (Yang, Moore, & Burton, 1995). Other models have been offered, tending to generally conform around the ADDIE model.

Tripp and Bichelmeyer's model is as an early RP instructional design often cited in the RP literature. This model outlines the RP design phases as: assess needs and analyze content; set objectives; construct prototype; utilize prototype; install and maintain system. Rapid prototyping includes the "parallel processes of design and research, or construction and utilization" (Tripp & Bichelmeyer, 1990, p. 37). Front-end analysis is only intended as a starting point in the process that quickly merges into the design phase. Tripp and Bichelmeyer noted that RP approaches hinge on the use of tools and skills that offer modularity and plasticity. Modularity is defined as the ability to add, remove, or modify the instruction without severely affecting the entire design. Related to modularity, plasticity of the design means that changes to the instruction incur only minor time and cost penalties. Both of these abilities result in a flexible design that is easily modified throughout the process.

Client's Role in RP

The working relationships and the interactions among clients and design teams are important aspects of the RP approach. The use of prototypes early in the development process stands in contrast to many development projects where the client does not see the product until it is nearly completed. The client's role in the process is multi-faceted and is often more involved. The client may serve as a subject-matter expert, an end-user, or a purchaser of the product (Tripp & Bichelmeyer, 1990). Due to the fact that the prototype is introduced early in the process the client is able to see a form of the final product, provide detailed feedback, and make formative recommendations. There has been little research, however, that has focused on the client's role in the RP process and its impact on the effectiveness of the RP approach to ISD.

RP Benefits

Proponents of the RP process have offered numerous potential benefits of the RP process. RP approaches hinge on early and consistent client feedback, which encourages an iterative and responsive design. The intense involvement of the client throughout the design process results in the identification and resolution of issues and problems earlier in the process, reducing the overall cost of the product (Piskurich, 2000). Additionally, RP approaches result in a customized, unique artifact, not a generalizable, universal design (Tripp & Bichelmeyer, 1990). The primary benefit offered for the RP process is that it reduces the time needed to complete a project, thus reducing the expenses of the project by reducing the cycle-time of the design. Jones and Richey's study (2000) of RP approaches in two ID projects found that "the RP approaches lived up to their promised benefits" (p. 79). RP approaches contributed to a cost-effective design, reduced design cycle time, and facilitated efficient development. They found that the RP process directed the client and the design team to think through the entire ID process in an effort to ascertain what the final product would be. As Tripp and Bechlmeyer noted, the "final test of rapid prototyping, like anything in the design sciences, is not whether it is based on true assumptions, but whether it is useful" (p. 41). Based on the findings of this and other studies, RP appears to be an efficient approach to instructional design in certain situations. However, more research is needed to investigate RP as an effective approach to instructional design, in terms of quality and usability.

Research questions

The research questions guiding the present study include:

RQ_1: To what extent does rapid prototyping impact the quality of the training product?

RQ_2: To what extent does rapid prototyping impact the role of the client?

RQ_3: To what extent does rapid prototyping impact the usability and customization of the training product?

Research Design

Due to the lack of research on RP addressing these questions, an exploratory design was deemed best suited, for this study. Utilizing mixed methods, a variety of data was collected over the course of the study, in a small-group trial. Creswell (2003) encouraged the use of mixed methods in such situations where the presence and role of the researcher are necessary, along with a purposefully selected site, events and individuals, while "…collecting and analyzing both quantitative and qualitative data in a single study" (p. 210). The research questions evolved during the development of this study, as part of this exploratory investigation. As Sink (2002) pointed out, studies have found that small-group trials are just as productive as large-group trials in terms of collecting data for the purpose of improving an instructional program. Thus using a small-group trial as a "strategy for developmental testing may not only be faster and easier, but it may be better as well, because more test and revision cycles are likely to be completed" (Sink, 2002, p. 21).

Data Collection

The instructional design team consisted of three researchers who were also instructional designers, one client, one supervisor, and two staff members. The RP approach resulted in both tangible and intangible results. The most important tangible result was the development and refinement of a prototype or working model of the instructional product. A working model of the instruction was developed earl32y in the process using the RP approaches. This working model was piloted during March 2006 providing the instructional design team with a rich set of information pertaining to the strengths and weaknesses of the designed product. In order to collect detailed descriptions of the instruction, multiple data collection methods were applied from various perspectives, involving the four types as described by Creswell: observations, interviews, documents, and audiovisual materials. Before the instruction, e-mails and notes from each meeting among members in the instructional design team were collected. During the instruction, the process was recorded by two researchers, including actual delivery time on each activity and content area, instructor's delivery and teaching style, student-student interactions, and student-teacher interactions.

After the instruction, a learners' feedback survey and an interview with the instructor were conducted. A feedback survey, based on the first level of Kirkpatrick's model of training evaluation (Rothwell & Kazanas, 2004; Swanson & Holton, 2001), was distributed to learners at the end of test session of the working model to collect their opinions about their learning experience. A follow-up interview was held five days after the session with the instructor to collect his feedback. The observations and feedback collected by the researchers informed the modifications and improvements that were implemented in the final training package.

Results & Findings

The research was conducted between February 2006 and May 2006 with an important milestone (a test session of the working model) at the beginning of March 2006. This time-frame set the tone for the rapid prototyping approach. The supervisor was a faculty member in a large university. The instruction was one of a series of leadership development courses for the purpose of preparing future leaders in these learners' chosen professions. Forty juniors majoring in engineering or business at a large top-ranked Midwestern University were recruited. The implementation of the instruction lasted for 90 minutes, and a follow-up activity was designed one month after the instruction. The client also filled the role of facilitator and content-expert. The client was highly experienced in leadership training, with over twenty years of teaching experience.

The Field Observation

The intense observation of the test session conducted by the researchers was well connected to the idea of the rapid prototyping approach. The direct observation offered the researchers a better perspective of the training solution being used in the field, with real interaction and real challenges. By using RP, the instructional design team was able to meet these challenges in a much more efficient manner than using a traditional ISD. The working model was amendable to the client's needs based on these observations. The observations were compiled and then analyzed by the researchers, the supervisor and the client, in an iterative process, supporting significant decisions aimed at improving the overall learning experience, while handling the time and quality dimensions.

The primary observations that led to decisions concerning the product were grouped according to the delivery and the content of the instruction. Observations concerned with the delivery of the training included time allotted, the general instructional strategy, and learners' reactions to the instruction. Observations concerned with the content included the addition of authentic situations as illustrations, the re-sequencing of topics, and use of multimedia. Decisions based on these observations led to the refinement of the training product. From these field observations it

was clear that the adoption of a rapid prototyping approach to the instructional design process analyzed in this study offered better chances of incorporating immediate and timely changes to the final product. These achievements were noted as very unique to the RP approach, and under regular conditions of the traditional approach to the instructional design process, such dynamic would not be as likely.

Feedback Survey Results

Participants were asked to complete a survey for evaluation purposes, based on the first level of Kirkpatrick's model of training evaluation (Rothwell & Kazanas, 2004; Swanson & Holton, 2001). The feedback survey was distributed immediately after the session and was voluntary. A five-point Likert Scale was employed. Nineteen learners completed the survey. Four evaluation areas were covered: content (2 items), methods of instruction (6 items), materials (4 items), and facilities and other resources (2 items). The items were scored on an agreement scale ranging from 1 (strongly disagree) to 5 (strongly agree). With the exception of one item pertaining to the evaluation of the classroom, all other items presented a mean score above 3 (neutral). Table 1 presents the summary mean scores and standard deviations for each area.

Table 1. *Evaluation Areas (Descriptives)*

Evaluation Areas	*Mean*	*SD*
Content	4.39	0.99
Methods of Instruction	3.94	0.94
Materials	4.06	0.85
Facilities and Other Resources	3.00	1.38

Obs.: n= 19

It is important to note the area "facilities and other resources" bears highest level of dispersion, besides presenting the lowest mean score. Basically, this area focused on the time allotted for the session and classroom infrastructure. The classroom was inappropriate for the learning experience, and the survey results confirmed this fact. However, these were all administrative issues, out of the direct range of control of the design team.

Issues and Opportunities

The two major obstacles to the delivery of the test session as intended was a reduction in the time allotted and the close quarters of the delivery environment. These two factors constrained the learners' performance and the overall effectiveness. The limited time forced the instructor to adjust the lesson outline and reduce the time spent on activities and content areas. For example, by the end of the session, four slides covering suggestions and remedies connected to the discussed leadership concept had to be read through rapidly by the instructor. As for the delivery environment, learners scored this factor poorly on the feedback survey (see Table 1).

Although these two factors were outside the instructional design team's control, they served to inform considerations and modifications for the final product. The training time required to effectively deliver the leadership topics and the importance of a delivery environment that helps to facilitate a group discussion are important factors that need to be reported and considered by the instructor. It is important to stress that these "adjustments" could improve several dimensions of the training, such as: rapport (e.g., instructor/learners), facilitating participation, exploring personal experiences, supporting application and transfer of learning, while creating a sense of follow-up (e.g., action plan).

Some learners reported confusion concerning the main concept focused on by this session. Although this can possibly be attributed to the limited time constraint, the instructional design team addressed this component by providing learners with opportunities to discuss and identify related behaviors and improvement strategies. This addressed some of the learners' feedback concerning the lack of interaction. The instructor also noted the lack of interaction during the delivery of the training and then rearranged the order of activities (on the spot) so that that a group discussion could be conducted. The change resulted in learners becoming involved in the discussion and the

topic. The high level of involvement of the client throughout the design of the instruction equipped the client to respond effectively to the learners' needs. This is an important contribution of the RP approach to ISD.

Although the design team designed several activities for the test session, some of them did not operate as intended. The problem was attributed to a lack of instruction provided to the students in completing the activity. More detailed guidance for activities proved to be a necessary modification for the final training product.

Changes in Final Training Product

Based on the observations and feedback along with the analysis involving the supervisor, client and designers, the final training product were adapted according to the following seven key decisions: (1) development and documentation of two alternative training formats (a 2-hour and 3-hour format should be provided for instructors to be implemented according to their own training context); (2) reordering of the topics and materials (new delivery sequence); (3) presenting the video clip and facilitating the discussion before mentioning the agenda;(4) facilitating the "Group Activity" before the discussion of the "Improvement Strategies"; (5) discussion of the "Questions to Consider" before focusing on the key topics of leadership (content areas); (6) development of additional discussion questions; and (7) inclusion of a handout covering "Clear/Unclear Points," along with a respective discussion (checking for understanding).

Conclusions & Recommendations

Informed decisions on alternative ways of combining resources to reach similar or even a better level of outcomes is likely to be one of the top priorities in the future for HRD. This paper registers an exploratory study on rapid prototyping as an alternative approach to the traditional ISD process based on a leadership program at a top-ranked large Midwestern University, focusing on the training and development dimension of HRD and its efficiency and effectiveness trade-off. According to Jones and Richey (2000), the design process is defined as a RP approach because: (1) a working model of the final product was employed early in the project, and (2) the instructional design tasks were completed concurrently. The driving force of a tight time frame to complete the instruction by the test session of the working model encouraged the use of the RP approach, with its established record as an efficient approach to ISD. However, being able to develop a training product in less time without loosing quality was an important factor, thus contributing to the development of the research questions explored in this study. Based on this research, evidence of rapid prototyping supporting the training design and development under strict drivers of time and quality was gathered.

RQ_1: To what extent does rapid prototyping impact the quality of the training product?

Based on the findings of this research, along with the literature review, it is innocuous to discuss the rapid prototyping framework without considering the time and quality proposition altogether. As observing throughout this study, the concept of quality is intensively dependent on an established set of parameters. This conformity quality approach is described by this relation: the higher the alignment of the final product to this set of parameters, the higher the perceived quality. With rapid prototyping the set of parameters is dynamically improved during the process, due to the higher fidelity of the design environment.

In this study, complementary proxies were used to gauge the quality of the final training product, beyond the perception of the researchers, based on a triangulation approach: perception of the supervisor, the instructor, and the learners. In all cases, with no exceptions, the training product, even in its early stage, received significant high and positive feedback in regards to its quality and conformity. An important element of the impact on quality is the intense and interactive involvement of the supervisor, designers and client during the entire design process and the involvement of learners mainly in the test session. Table 1 presented the learners' perception of quality, with a clear positive feedback on the achievement of the educational objectives.

Therefore, the answer to RQ_1 is that although challenged by a very tight deadline, the overall final quality of the training product was very high. Based on different perspectives (designers, client, supervisor, and learners), this reflects the appropriateness and usefulness of rapid prototyping in such situations.

RQ_2: To what extent does rapid prototyping impact the role of the client?

According to an interview and a client report submitted to the instructional design team's supervisor, the client in this study was satisfied with the RP approaches used to develop and implement the training module. Due to the fact that the client was highly involved in each phase of the instructional process from analysis to evaluation, the client expressed a high level of ownership and satisfaction with the product. Instead of separated job tasks, the group worked as one collaborative team with continuing communication and modification of the module. The boundaries

between the often segmented roles involved in the traditional approach to ISD seemed to dissolve (Jones & Richey, 2000). In this case, the client served as a subject-matter expert, facilitator and purchaser of the product simultaneously. As a subject-matter expert, the client provided research materials and transmitted knowledge. As the facilitator, the client was all the more dedicated to being highly involved in the development of the instruction. This level of involvement was positively reflected in the ability of the client to respond to the learners' needs during the delivery of the instruction during the test session, deviating from the design of the instruction, improving the instruction on-the-spot. This level of involvement is an important aspect of the RP approach. As a purchaser, the client evaluated whether the content and the design were suitable and useful. Based on a final interview the client was extremely satisfied with the final product.

Stimulated by RQ_2 the findings of this study join the existing literature on the role of the client within the RP approach. These results also suggest that due to the fact that much is contingent upon the client's high level of involvement in using RP additional research is needed to bring more light on factors that encourage and sustain it. With further research more can be concluded about whether RP is only successful in certain situations, which are attributable to certain client characteristics or roles (subject-matter expert, facilitator, purchaser, and etc.).

RQ_3: To what extent does rapid prototyping impact the usability and customization of the training product?

According to Tripp and Bichelmeyer (1990), one of the major benefits of RP approaches is to customize and tailor learning content to client's needs. Applying RP approaches in action, a similar result was discovered in this case. Based on the field observation, diverse learners' needs had to be addressed during the test session. In addition, through the interview with the client, a need to create a more flexible and customized training module was apparent. In the future application of the module, the client may perceivably conduct the training program to learners from different backgrounds and cultures, such as employees in China. Therefore, two different formats of the training module were created. A three-hour format and two-hour format were developed. However, the two formats are not limited to two or three hours, but are comprised of different levels of learning activities and instructional strategies. Depending on the time, learners' backgrounds, and instructional resources, the module allows clients to customize the training by combining different components. As a result, the usability of the final product was increased by its flexibility.

When Noe (2005) discussed future trends of training and development, he identified three reasons why the training department will develop partnerships and will outsource: (1) downsizing has caused reductions in training staffs, (2) knowledge is becoming the main organizational currency, and (3) demand for training services is fluctuating. Traditionally, internal training professionals would go to their company's training department and request a specific class. However, due to the three reasons, outsourcing is becoming a trend, and accordingly, customization is arising as a critical issue, especially for small and medium enterprises, which may have minimal budget for training and development. Therefore, Rossett and Sheldon (2001) recognized performing analysis to customize and tailor content as one of eleven roles of future training professionals. In this end, RP can be a useful method to increase the usability of training and to reduce the cost and energy of revision.

An important comment related to the generalization of these conclusions must be registered. An inverse relationship between the strength of the research method adopted, in terms of using mixed methods within a particular context and conditions, and the generalization of its results to situations other than the one supporting these findings, is expected to exist. In other words, there is a controversial methodological discussion on the direct transfer of these results to different contexts and conditions that must be considered.

Contributions

Given the preceding discussion, the results and findings from this research can provide important contributions to the use of rapid prototyping within the ISD process. Rapid prototyping provides a way to create a better quality of instruction under time and resource constraints. In fact, due to concerns in exploring details of the rapid prototyping process, and the involvement of an experienced instructor and supervisor, this research presented enough evidence to encourage the reader to take advantage of the process and findings of this study as they showed to be beneficial when tackling real-world instructional design problems. Moreover, according to Gall, Gall & Borg (2003), that "a researcher can never prove a theory, but only support it" (p. 9), throughout this study elements and arguments to analyze rapid prototyping as a way of improving the effectiveness and efficiency of instructional design were provided. In this sense, this study contributes to the field of HRD in both dimensions: academic and practice. This study provides evidence that utilizing the RP approach not only results in an efficient process, but also a high quality

and usable product with a high level of client involvement. Practitioners can use these results to support their own use of the RP approach to ISD.

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