Achieving Training Effectiveness through elementK Systems: An Empirical Study

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Abstract

The growth in the application of information technology to learning/training underscores the need to understand the impact of these technologies. This paper reports the results of a multi-period quasi-experiment focusing on two e-learning methods: elementK and video-based method. Drawing on the two foundational disciplines of Information Systems and Education, this study presents a theoretical model, based on Adaptive Structuration Theory, which focuses on the learning process involved in technology-mediated learning. The model describes the effect of learning methods as well as the important role of faithful appropriation of learning methods on learning outcomes. Results of the study show a significant influence of elementK on specific learning outcomes. In addition, the study finds that appropriation is an important determinant of the extent of these effects. The study provides important research implications for theory and practice. Researchers and practitioners need to focus, not only on the learning methods, but also on their appropriation.

Background

Training within organizations is one of the most pervasive methods for enhancing productivity of individuals and communicating organizations’ goals to new personnel. Consequently, it is estimated that by year-end 2009, 60% of core business processes and software will include an e-learning or technology-mediated learning component [9]. We are seeing similar trends in universities and other educational institutions [8]. For example, in 2004, over 90% of all public institutions offered some form of e-learning courses [20]. While there has been many arguments regarding the cost and geographic benefits of e-learning, multiple concerns still exist regarding the effectiveness of the e-learning.

- E-learning studies, even when analyzing similar technologies, have yielded inconsistent results.
- Lack of a theoretical comprehensive framework to guide and integrate e-learning results.
- Limited understanding exists regarding the conditions under which e-learning is effective.
- Current research ignores the beliefs and assumptions of designer/developer.

The paper outlines a theoretically grounded research model followed by the results of a laboratory study. It reports a study comparing two prominent e-learning methods: elementK with video-based method. Drawing on the multiple streams of literature, the next section presents a review of e-learning research with a focus on end-user training. Section 3 presents the research model for the study. Section 4 outlines the experimental research design used to test hypotheses derived from the research model. We conclude by summarizing and interpreting the findings and outlining future research areas.

Research Design and Hypothesis

Most of the new courseware systems such as elementK, skillsoft etc, used by most business and academic organizations, demonstrate actions (vicarious learning) followed by an opportunity to replicate the actions in simulated settings (enactive learning). The underpinning of such a design is the
Social Cognitive Theory. The theory states that it is not just the exposure to simulation, but the learner’s actions in exploring, manipulating, and influencing the environment that counts towards learning [2].

Social cognitive theory has become one of the most prevalent theories for research in Information Systems and Education. This research provides substantial positive evidence regarding the effectiveness of vicarious learning, although much of it is done in non e-learning environments. Additionally, research has failed to answer important questions regarding the effectiveness of combining vicarious and enactive learning in e-learning systems such as elementK, conditions under which such learning would be effective, as well as the influence of e-learning technology on learning outcomes. Finally, research has failed to provide consistent guidelines to developers for enhancing training [10].

Given the complexity and the breadth of issues, a new approach to understanding the learning phenomenon is needed. Adaptive Structuration Theory (AST) [5]. Theories are important since they provide a comprehensive yet parsimonious way to explain the world. AST provides an ontological framework of constructs, which helps us organize and understand the usage and outcomes from e-learning systems such as elementK.

AST is built upon two basic premises. The first premise relates to the influence of structures embedded in a context. Structures are formal and informal procedures, techniques, skills, rules and technologies, embedded in elements of a learning method [5]. AST also states that in a directed or purposeful social system, structures reflect the values and norms of the designer, i.e., they are designed to reflect a spirit [5] In the model (see Figure 1), the spirit is derived from the learning goals and epistemological perspective taken by the designer. As discussed earlier, contemporary e-learning systems are based on cognitive perspective, with the learning goals focused on cognitive, skills and satisfaction levels.

This study compared a commercially available e-learning delivery system, i.e. elementK with standard video-based learning method (another extensively used e-learning method). The video-based learning method was exactly the same in terms of content and presentation to elementK, except for an unstructured practice session instead of a simulated practice session.

Much of the trade and academic literature comparing e-learning systems has focused primarily on the features of e-learning systems (such as demonstration, quality of graphics, resources links, etc.). However, given the multitude of features and even greater number of ways to implement them, using features to distinguish e-learning products is impractical. Alternatively, our research model argues for a dimensional analysis of the product. A dimension describes some aspect or characteristic of structure as implemented by a feature or a set of features. Scaling of these dimensions was accomplished by consulting the literature, reviewing the software and the help information [5]. We discuss these dimensions next.
Technology-Mediated Learning Methods

The cognitive perspective outlines two learning methods: Vicarious learning and Enactive learning [2]. Drawing on Education and EUT literature, five core dimensions of vicarious learning were identified and scaled: realism, authenticity, model credibility, restrictiveness, and production pattern. Table 1 describes these dimensions and how they were implemented in the learning methods. As shown in Table 1, the levels of each of the dimensions are similar in both learning methods, except for production pattern. There exists no research evidence that this difference would lead to major differences. While vicarious treatments could have been achieved with smaller content chunks and more immediate production, we wanted the treatments to reflect the standard approach to vicarious training in practice.

Table 1: Vicarious Learning Dimensions

<table>
<thead>
<tr>
<th>Vicarious Learning Dimensions</th>
<th>Video Learning Methods</th>
<th>elementK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Restrictiveness of Demonstrations:</strong> The degree to which a system limits an action</td>
<td>High - Controlled script followed by instructor</td>
<td>High - Controlled script followed by system</td>
</tr>
<tr>
<td><strong>Richness:</strong> The quality of audio/visual presentation in the system</td>
<td>High - Video clearly showed all aspects of demonstration</td>
<td>High - System showed all aspects of the actions demonstrated</td>
</tr>
<tr>
<td><strong>Authenticity:</strong> The degree to which the actions and consequences represented by the system are real</td>
<td>High - Actual Excel system used to demonstrate</td>
<td>High - Simulated Excel system used to demonstrate</td>
</tr>
<tr>
<td><strong>Model Prestige and Competence:</strong> The extent to which the model demonstrates actions that observers believe they will have to perform as well as the level of reputation of the learning model</td>
<td>High - Highly rated instructor performing actions - Content same across treatments</td>
<td>High - Highly rated e-learning system - Content same across treatments</td>
</tr>
<tr>
<td><strong>Production Pattern:</strong> The lag between demonstration of an action and practice by the learner</td>
<td>Delayed Production - All procedural/behavioral and declarative knowledge given to the students before practice</td>
<td>Immediate Production - “Show me” and then “I do” strategy (student presented with small amount of content and then they would practice immediately with system providing specific feedback)</td>
</tr>
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</table>

Next we focus on the enactive learning dimensions. Based on the literature, seven core dimensions that influence enactive learning were identified and scaled: production pattern, structuredness of practice, restrictiveness of practice, feedback, guidance, richness and authenticity (see Table 2). While all learning methods involved practice, features in elementK enables higher levels of enactive learning dimensions. For example, feedback and guidance help to correct deficiencies before they move to the next step, contrary to practice where the enactive learning is delayed until the end of the module. Similar arguments regarding the structuredness and restrictiveness of practice exists in the academic literature.

Drawing on SCT, we argue that higher levels of these enactive dimensions represent a better implementation of the theory and consequently, should result in higher levels of learning outcomes. Since enactive learning reinforces the same underlying cognitive process of human thought [3, 23], we argue that the use of elementK should enhance the learning outcomes.

**H1:** Individuals using elementK will perform better on learning outcomes when compared to video-based methods.
### Table 2: Enactive Learning Dimensions

<table>
<thead>
<tr>
<th>Enactive Learning Dimensions</th>
<th>Video Learning Methods</th>
<th>Scale of dimensions &amp; features used to implement</th>
<th>ElementK</th>
<th>Scale of dimensions &amp; features used to implement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Pattern: The lag between demonstration of an action and practice by the learner [18]</td>
<td>Delayed Production</td>
<td>- All procedural/behavioral and declarative knowledge given to the students before practice</td>
<td>Immediate Production</td>
<td>- “Show me” and then “I do” strategy (student presented with small amount of content and then they would practice immediately with system providing specific feedback)</td>
</tr>
<tr>
<td>Structuredness of Practice - The extent to which technology imposes its procedures on the learner [17]</td>
<td>Low - Practiced what they wanted to or what they remembered</td>
<td>High</td>
<td>Practiced specific things demonstrated and given structured exercises to do</td>
<td></td>
</tr>
<tr>
<td>Restrictiveness of practice: The degree to which a system limits an action [19]</td>
<td>Very Low - Students had total control of their actions</td>
<td>Very High - Student actions were guided by the system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback: The degree to which a system provides a response, including correction, addition or approval and speed of response [6, 16]</td>
<td>Low</td>
<td>- Immediate feedback provided by the system</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Feedback restricted to syntax and semantics and not tied to learning goals</td>
<td>Very High</td>
<td>- Immediate feedback provided based on student action</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Feedback linked to learning goals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guidance: The degree to which a system provides direction or advice towards a course of action [8]</td>
<td>Low</td>
<td>- Restricted to what the system provided and not linked to learning goals</td>
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<tr>
<td></td>
<td></td>
<td>- Student may not be able to recover and must start over</td>
<td>Very High</td>
<td>- Directly linked to learning goals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- System provided guidance to help students recover and correct their action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Richness: The quality of audio/visual presentation in the system [21]</td>
<td>Medium</td>
<td>- Hands on practice on real system</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Quality of information presented is lower since students can get lost without knowing what to do</td>
<td>High</td>
<td>- Used simulation system to practice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- High quality information because simulation presented the students with context specific information</td>
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<td></td>
</tr>
<tr>
<td>Authenticity: The degree to which the actions and consequences represented by the system are real [12]</td>
<td>High</td>
<td>- Outcomes of actions shown from real system</td>
<td>High</td>
<td>- Outcomes of actions shown from simulated system that modeled the real system</td>
</tr>
</tbody>
</table>

### Process Impact

The extensive focus on the features of an e-learning system in trade and academic literature has resulted in ignoring the learning process. According to the model, the learning process, known as appropriation, involves the learners utilizing and adapting learning method structures (forward arrow in Figure 1).

The faithful-ironic appropriation distinction captures the degree to which participants interact in a manner consistent with the spirit of the learning method [5]. When well-designed and relevant structures are used as intended by the designer (i.e. faithfully appropriated), the correct structural dimensions get operationalized which in turn should lead to higher learning outcomes. An unfaithful or ironic appropriation of well-designed and relevant structures, on the other hand, might result in lower learning outcomes. Although the focus of the study is on learning methods and the learning process, appropriation of structures may be supported by providing help, through facilitation or other forms of support [11] (see Figure 1).

Given the lack of e-learning research in this area, we drew on the referenced disciplines to develop a hypothesis. In terms of technology effect, early research in Group Support Systems literature shows a positive effect of the level of faithfulness on decision outcomes [7]. In addition, faithfulness of use of
technology has been found to have a strong positive correlation with satisfaction [3]. Thus, we argue that the level of learning outcome is moderated by the level of appropriation of these structures.

**H2:** The effectiveness of the e-learning will be positively moderated by the level of faithfulness of appropriation e-learning technologies.

Both academic and trade publications have observed that even with the same learning method, learning outcomes tend to change [4]. As time progresses, some learners learn more while others do not. As shown in Figure 1, learning method structures are constituted recursively as participants regularly interact with them, and thus, shape the set of rules and resources that serve to shape their interaction (circular arrow in Figure 1) [15]. Participants might drop structures that do not work, or come up with new structures based on their experience. A positive change (increase in faithfulness) occurs to the extent that the changes are beneficial while a negative change reflects a reduction in the level of appropriation. Thus, participants are expected to change the way they interact with the learning method, and inferences regarding the changes in learning outcomes are based on these changes [14]. Thus, we argue:

**H3:** Changes in the faithfulness of appropriation of e-learning technologies over time will positively moderate the changes in learning outcomes over time.

**Experimental Procedure**

The learning goal was to train participants in a contemporary application package (Microsoft Excel 2003). The experiment emulates introduction of an application package in an organization and subsequent end-user training. Given the complexity of concepts covered, the training was designed to be done in three logically separate sessions, each building on the previous one. The first phase (Week 1) trained participants on working with existing workbooks. The second phase (Week 2), building on the first one, trained participants on analyzing and managing data in Excel. The third phase (Week 3), building on the second one, trained participants on writing formulas in Excel.

Overall, the participants went through an initial introduction session followed by three training sessions. Each session was 75 minutes. To control for time effects, the video/elementK demonstration times were equal across all treatments. There was a week between sessions. As an additional control, students were not allowed to repeat any part of demonstrations across the treatment.

The sample for the experiment was drawn from an introductory MIS course for undergraduates from a large southern university. Student incentives included course credit for participation and monetary incentive for performance. Similar to earlier research [13, 22], all prospective participants were asked to take an Excel pretest. Only participants with scores less than 35% were included in data analysis. Students were randomly assigned to various treatments/learning methods.

Overall, 357 students participated in the experiment with a usable sample of 230 (~61%). The final numbers of participants considered for analysis in each treatment are: 113 students in LM1 (individual video) and 117 in LM2 (individual WBT). A one-way ANOVA and CHI-square confirmed that the randomization procedure for GPA, college major, motivation and pretest knowledge provided an even

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For an extensive review of the study see Gupta, New Approaches to End-User Training. VDM Verlag Dr. Mueller e.K, Saarbrücken, Germany, 2008.
distribution of the subjects (p<.05) except for gender differences. Thus, gender was included as a covariate.

**Results and Interpretation**

**Learning Method Effects**

Three learning outcomes were measured to test the effectiveness of the e-learning methods: Self-efficacy (measured using a 5-item instrument), Satisfaction from the learning process (measured using a 3-item instrument), and Cognitive knowledge (measured using a 15 question quiz).

The findings from the study shows that the use of both vicarious and enactive learning in elementK had a significant positive impact on cognitive knowledge and self-efficacy outcomes but not on satisfaction (see Table 3).

**Table 3: Summary of Results**

<table>
<thead>
<tr>
<th></th>
<th>Self-efficacy</th>
<th>Cognitive knowledge</th>
<th>Satisfaction</th>
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<tbody>
<tr>
<td><strong>e-learning effect (H1) - Effect of elementK on dependent variables</strong></td>
<td></td>
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</tr>
<tr>
<td>elementK</td>
<td>Significant (Δ μ=0.787)</td>
<td>Significant (Δ μ=1.171)</td>
<td>Not significant</td>
</tr>
<tr>
<td><strong>Process effect (H2) - Initial appropriation of treatments on initial dependent variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elementK appropriation</td>
<td>Significant (Attitude β = 0.73)</td>
<td>Significant (Attitude β = 1.32, Faithfulness β = 0.56)</td>
<td>Significant (Faithfulness β = 0.50)</td>
</tr>
<tr>
<td><strong>Longitudinal process effect (H3): Rate of change in appropriation on rate of change in dependent variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elementK appropriation</td>
<td>Not significant</td>
<td>Not Significant</td>
<td>Significant (Δ Attitude β = 0.525)</td>
</tr>
</tbody>
</table>

Note: “Significant” is based on meeting the p<0.05 criterion. Only significant values shown.

In the elementK treatment, while cognitive knowledge and self-efficacy showed significant improvement, a great variance in satisfaction from the learning process was observed (σ= 3.89 on a 7 point scale, μ= 3.7, range = 7-2). This variance was also expressed in the qualitative data gathered. One student commented, “I would prefer to be taught by a human being than by a computer...” while another commented “…it really helped me develop into a real go getter. Thanks elementK!” This indicates that some participants were very satisfied with the use of elementK, while some were not.

The key to these differences in satisfaction appears to be the attitude towards the use of technology. Given the context of the experiment, participants viewed the use of elementK as an alternative to the use of instructor-led training. Participants who had positive attitudes towards the use of technology were eventually more satisfied with the learning process than participants with an unfavorable attitude were. This is captured in detail in the learning process discussion.
Process Effect
Given the positive results of the above treatment effect of technology, the focus here shifts to the conditions under which such effectiveness can be obtained. Appropriation of the elementK was argued as the core condition for its effectiveness. Findings from the study support this argument (see Table 3).

The interpretation of the influence of initial technology appropriation on each learning outcome is almost intuitive. The more elementK is used as designed, the more the gain in cognitive knowledge. Interpreting this, one can conclude that, if a well-designed elementK is used as it is intended to be used, it will lead to higher ability and more satisfaction. Satisfaction was also, though to a lesser degree, influenced by faithful use. The more diligently students used the e-learning system, the more satisfied they became. The analysis further showed that no significant change in faithfulness was observed over time. Given the ease of use of technology, experiment guidelines and supervision, this is not surprising.

Attitude towards technology is an affective reaction. Consequently, self-efficacy and satisfaction were both strongly influenced by attitude towards technology. This suggests that individual attitude towards technology is an important construct that needs to be focused on in both research and practice. A negative attitude towards technology acts as a barrier in enhancing the self-efficacy and satisfaction of participants. A significant positive change in attitude occurred as students used elementK over time. This is an important finding showing how appropriation changes over time. For example, a student commented, “elementK continued to be a help…”. Thus, as students get positive experience in their learning with elementK, their attitude towards elementK use in learning/training situations improves. Most importantly, this change in attitude had a significant effect on improving satisfaction with technology use. Thus, positive attitude and faithful use have a strong influence on learning outcomes and organizations should invest in developing and ensuring these before and during the training sessions.

Implications for Practice
The study has substantial implications for practice. These implications can be broadly classified into implications for users, designers and educators. Table 4 summarizes these implications. They are further discussed below.

Table 4: Practical Consequences

<table>
<thead>
<tr>
<th>Practical consequences</th>
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<tbody>
<tr>
<td>1. Well designed e-learning technology such as elementK enhances self-efficacy and cognitive knowledge.</td>
</tr>
<tr>
<td>2. Initial elementK appropriation has a significant effect on initial self-efficacy, cognitive knowledge and satisfaction as well as downstream effects on self-efficacy and satisfaction.</td>
</tr>
<tr>
<td>3. Designers need to focus on empirically-supported learning theories when designing e-learning technology</td>
</tr>
<tr>
<td>4. Designers need to focus on the structural dimensions of their design.</td>
</tr>
<tr>
<td>5. Educators and designers need to focus on appropriation support to enhance appropriation of elementK</td>
</tr>
</tbody>
</table>
This study used two e-learning methods in end-user training and tested their effectiveness. Among these, elementK represented a significant improvement in the potential to learn. These e-learning technologies provide an ability to learn anytime, anywhere, and also provide a better mechanism for learners to test their mental models. Additionally, the positive effect of e-learning technologies continues over time. This is a very encouraging result for end-users.

E-learning embedding enactive learning in a simulated environment is positioned to revolutionize existing ways of learning (Aldrich 2004). The positive results from the micro-simulated environment of elementK are very encouraging for application of these technologies in training, especially end-user training applications. With the number of applications and the speed of change of end-user software, e-learning technology can provide a mechanism for fast-paced mass training. The study also has a direct application to universities, especially in their skill building courses. Results of the study show that e-learning technologies can be used in place of the instructor for skill development, with the instructor acting as a facilitator.

However, this result is contingent on the faithful use of e-learning technology by the users. Faithful use, especially a positive attitude towards e-learning technology is a substantial influencer on the extent of learning. It is also found that over a period of time, attitudes towards elementK became more favorable, improving learning outcomes. A practical implementation of this is to encourage participants to continue with e-learning solutions for a longer period of time, as experience helps in enhancing attitudes towards e-learning. More importantly, it shows the importance of developing a positive attitude up front.

From a designer’s perspective, there is an important implication. First, e-learning technology designers need to shift their attention towards incorporating learning theories into their software; i.e., focus on what learners need to successfully learn and how it is provided in the technology. For example, in this study, an e-learning technology incorporating social cognitive theory provided a basis for treatments. The focus of the technology treatment was to incorporate enactive learning in addition to vicarious learning in a simulated environment. With the growing investment in simulations by organizations, this study suggests that designers need to focus more on the realism and feedback structural dimensions for effective learning outcomes. However, more research is needed in the evolving simulation technology.

From an educator’s perspective, this study also provides research evidence for investments in technology-based training programs. Business and consultants should, thus, be more proactive in exploring these options. More importantly, this study provides pedagogical guidelines for proper implementation of training programs. The importance of appropriation of e-learning technologies structures highlights the future role of trainers. The future goal of trainers should be to include appropriation support to participants. Results suggest that technology appropriation support is needed early in the training program.

Overall, this study provides a richer view of designing contemporary training programs, both in classrooms as well as virtually. These outcomes can be used not only by corporate businesses/consultants/trainers, but by instructors in K-12 and universities.
Potential Next Steps

For e-learning technologies, the research clarifies the need to incorporate learning theory in the development of learning systems, especially learning-from-computer software. The results of this study can also be extended to other simulation technology that uses technology grounded in social cognitive theory. With simulation-based learning set to revolutionize existing ways of learning [1], it presents a very promising area for future research. However, and more importantly, this research states that the impact of a simulation-based learning method should be evaluated based on its spirit and structural dimensions, as well as the appropriation of these structures by the learners.

This research also opens up the black box of learning processes not studied by earlier researchers. We found that appropriation of the learning method structures plays an important role in determining the learning outcomes. An important implication of this finding is that future researchers need to account for the level of appropriation in their studies. In addition, the effects of interventions that support appropriation, such as scaffolds, represent an important area for future research.

The significant effects of covariates and attitude in this study emphasize the impact of learner differences on learning outcomes. While considerable research has been done in this area, much of this research has focused on direct impacts on learning outcomes. However, as outlined in the research model (Figure 1), we argue that these individual differences can also have an impact on the learning process. Future research needs to look at both process and outcomes impacts. With the increase in self-paced learning in organizations and the ability to customize e-learning, further research is needed in this area.

In closing, the contributions to research from this study are many. It enriches our understanding of effectiveness of e-learning. Most importantly, it provides support for our AST based research framework for investigating e-learning within end-user training. The study extends our understanding of AST in another technology context. The results provide contributions to both IS and Education fields. The analysis methods used in this study also provide a contribution in terms of the first time use of stacked group modeling in a longitudinal experiment in IS. A rich future research agenda was outlined for those interested in pursuing e-learning research.


