THE EFFECTS OF ARCS-STRATEGIES ON SELF-REGULATED LEARNING WITH INSTRUCTIONAL TEXTS

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Abstract

The purpose of this study was to examine the effects of a motivationally designed instructional text on motivation and learning. The foundation for motivational design was provided by the combination of a model of motivation in self-regulated learning and the ARCS-approach. The model of motivation is based on concepts like expectancies, incentives, and action control. The ARCS-approach included instructional strategies to enhance attention, relevance, confidence, and satisfaction. Within an experimental study, 75 undergraduate students learned with self-instructional texts. One group learned with a text in which ARCS-strategies were implemented, the other group with a text without any motivational features. Results showed that the ARCS-strategies leaded to positive and negative effects on different motivational indicators of self-regulated learning (i.e., situation-outcome-, action-outcome-, outcome-consequence-expectancies, incentives, action control, personal evaluations of the learning process, and short- and long-term knowledge acquisition). Finally, implications for further research and instructional design are discussed.

Keywords: motivational design of instruction, text-based learning, self-regulation, instructional design

The Effects of ARCS-Strategies on Self-Regulated Learning with Instructional Texts

Self-regulated learning needs motivational support in order to continue over time. Within instructional contexts, this support can be realized by motivational instructional design. Approaches from Keller (1983, 1997, 1999) and Malone and Lepper (1987) concern instructional strategies which can be used to increase motivation during learning in general. Especially, the A(ttention)R(elevance)C(onfidence)S(atisfaction)-approach from Keller (1983, 1997, 1999) stimulated considerably empirical research showing in general that motivational instructional strategies influenced motivation in different media-based environments (Chang & Lehman, 2001; Chyung, Winiecki, & Fenner, 1999; Means, Jonassen, & Dwyer, 1997; Shellnut, Knowlton, & Savage, 1999; Song & Keller, 2001; Visser, 1998). However, on the one hand, this kind of research did not test the effects of the ARCS-approach on modern theoretical concepts focusing on motivational aspects of self-regulated learning. On the other hand, given research did not concern learning over a longer period of time with self-instructional texts which often build the instructional basis in current distance education and e-learning scenarios (e.g., Bellon & Oates, 2002). In order to establish a corresponding line of research, the ARCS-approach must be combined with a model of motivation in self-regulated learning. Rheinberg, Vollmeyer, and Rollett (2000) presented such a model which can be related to the instructional strategies of the ARCS-approach (see Figure 1). The resulting model describes an iterative process: A self-regulated learner finds himself attracted to different goals, then, through given information, he compares the different goals in respect to their related expectancies or incentives and selects one goal as intention for acting. After an intention is given, the learner starts activities to accomplish the goal which is linked with this intention. In order to be successful, action control processes accompany the transformation of the intention into action. During acting, new experiences produce a new indefinite goal status, and so on. The iterative process of motivation directed to self-regulated learning will stop, when all given goals are reached and/or when no new goals appear.

Figure 1

The relationships of the ARCS-approach to a model of motivation in self-regulated learning based on Keller (1983, 1997, 1999) and on Rheinberg, Vollmeyer, & Rollet (2000)

Motivational processes in self-regulated learning			Instructional strategies	
Indefinite goal status				
↓	Situation-Outcome-Expectancy Action-Outcome-Expectancy	←	Confidence	Attribution modeling Expectancy for success Challenge setting
	Outcome-Consequence-Expectancy Incentives	←	Satisfaction	Equity Natural consequences Positive consequences
Intention				
↓	Attention Control	←	Attention	Perceptional arousal Inquiry arousal Variability
	Encoding Control Cognition Control	←	Relevance	Goal orientation
	Emotion Control Motivation Control			Motive matching
	Environment Control			Familiarity
Action				

Note.

Situation-Outcome-Expectancy = the assumption that a given situation will lead to the desired outcome on its own

Action-Outcome-Expectancy = the probability that one´s action will lead to the desired outcome

Outcome-Consequence-Expectancy = the probability that an outcome will have the desired consequences

Incentives = the consequences of an action outcome and/or the activity itself the person is striving for
Attention Control = control of attentional focus to support the current intention
Encoding Control = selective encoding of a stimulus that is related to the current intention
Cognition Control = parsimony of information processing and stopping rules to optimize decision making
Emotion Control = inhibiting emotional states that might undermine the efficiency of intention protection
Motivational Control = strengthening the link from self-regulatory processes to their own motivational basis
Environment Control = higher order strategy that supports emotion and motivation control strategies
Attribution modeling = provides feedback that supports learner ability and effort as determinants of success
Expectancy for success = makes aware of performance requirements and evaluative criteria
Challenge setting = provides multiple achievement levels that allow to set personal standards
Equity = maintains consistent standards and consequences for task accomplishment
Natural consequences = provide opportunities to use acquired knowledge in real or simulated situations
Positive consequences = provide feedback that will sustain the desired behavior
Perceptional arousal = gains and maintains attention by use of novel, surprising, incongruous, or uncertain events
Inquiry arousal = stimulates information-seeking behavior by questions or problems
Variability = maintains interest by varying the elements of instruction
Goal orientation = presents objectives and utility information, or presents or lets choose goals for accomplishment
Motive matching = uses instructional strategies that match the motive profiles of the learners
Familiarity = uses concrete language, examples, and concepts that are related to the learner´s experience and values

Within this combination of models, it is assumed, that within a first stage, a self-regulated learner finds himself in an indefinite goal status. This status is transformed into an action-guiding intention, when low situation-outcome-expectancies (SOE), high action-outcome-expectancies (AOE), high outcome-consequence-expectancies (OCE), and high incentives (I) are given. In a second stage, the resulting intention is transformed into a certain action, whereby the intention must be supported by action control (i.e., attention, encoding, cognition, emotion, motivation, and environment control mechanism). The self-regulated learner can be supported within the different stages by instructional strategies proposed by the ARCS-approach. Instructional strategies concerning the confidence-parameter can be linked with SOE (i.e., the instructional strategy of attribution modeling) and with AOE (i.e., expectancy for success and challenge setting). For example, if learners are told that effort is necessary to be successful in learning, then SOE are kept low, because learners will not think that a given situation will lead to a desired outcome without any action. AOE represent the concept of "probability of success" which can be influenced by making learners aware of evaluative criteria and by providing multiple achievement levels. OCE and incentives are related to satisfaction-focusing instructional strategies dealing with equity (realizing consistent outcome-consequence relationships), or natural and positive consequences (for stimulating the perception of incentives). Attention influencing instructional strategies (i.e., perceptional and inquiry arousal, or variability) can be linked to attention control. Goal orientation as part of the instructional strategies related to relevance should have an effect on encoding and cognition control, because it provides learners with information about what is important for understanding and learning. Motive matching represents an instructional strategy for supporting emotion and motivation control, because learners are pointed to concentrate on their personal needs and wishes. Finally, instructional strategies enhancing familiarity can be related to environment control, because environments which are familiar to learners need less cognitive effort (and action control) for handling them than unknown environments.

In general, the ARCS-strategies should have positive influences on expectancies, incentives, and action control processes and on knowledge acquisition, because there were stringent theoretical connections and the ARCS-strategies were formulated based on comprehensive empirical motivational research. However, this positively assumed influence can be questioned. First, it is difficult to find the right number and usage frequency of instructional strategies. Too few strategies might have no significant influence on motivational parameters, too many strategies might have unknown or even negative side effects. Second, it is obvious, that some instructional strategies will enhance motivation, but not for all types of learners. Different learners prefer different strategies because of their learning experiences from the past and because of individual needs. Third, motivational effects vary in their duration. Many instructional interventions related to motivation are based on short-term activities. However, many motivational problems and therefore the necessity to intervene arise after mid- or long-term learning activities. Fourth, ARCS-strategies were not tested within learning environments based on self-instructional texts and on self-regulated learning, but primarily in computer- or teacher-controlled environments. Instructional strategies work differently in teacher- or computer-directed scenarios compared to learner-centered scenarios, because within one scenario external factors (e.g., teaching behavior) influence significantly motivation, but within the other scenario more internal factors (e.g., being able to motivate oneself without the help of others) are essential (e.g., Lee & Boling, 1999).

Within this study, the effects of ARCS-strategies on theoretically relevant expectancies, incentives, perceived action control, and other indicators of self-regulated learning (personal evaluation of the learning process and knowledge acquisition) are investigated based on learning with self-instructional texts. For each of the four ARCS-dimensions, one instructional strategy is implemented in instructional texts and tested in its short- and long-term effects. It is expected, that the ARCS-strategies can trigger motivational processes which occur in self-regulated learning.

Method

Participants, Design, and Procedures

Sixty-seven female and eight male university students with an average age of 24 years participated in this experiment. All students attended a course in research design at the University of Salzburg and got reward points for course examinations. Students were randomly assigned to the experimental conditions.

The experiment was based on an one-factorial design. As experimental condition, the motivational design of the instructional texts was manipulated. One half of the students (control group, n = 39) was presented an instructional text without motivational features. The other half of the students (experimental group, n = 36) got an instructional text designed according to the ARCS-approach.

At the beginning of the experiment, the subjects were informed about their task (learning with an instructional text) and the duration of the experiment, i.e., three sessions of about 90 minutes each. Then they had to complete a pre-test questionnaire including general questions (age, sex, etc.) and questions about expectancies, pre-knowledge, perceived incentives, and perceived action control. After about 15 minutes, students started to learn with the instructional text for about 75 minutes. Students were allowed to make notices and to highlight passages within the text. After a week, the second session was undertaken. Students were instructed to learn as much as possible with the instructional text. After 75 minutes, a first test for knowledge acquisition was taken. Within the third session a week later, after a 60-minutes learning phase, students were asked to answer questions concerning expectancies, incentives, perceived action control, and personal evaluations of the learning process (experience and preference). They also had to finish a second knowledge acquisition test. Six weeks after the third session, students were confronted with the final knowledge acquisition test which took about 90 minutes.

Materials and Instruments

As learning environments, instructional texts about the issue of research designs were developed (e.g., Campbell & Russo, 1999). Within the experiment, two different forms of instructional texts were used. In the version "without ARCS", students had to learn a self-instructional text without any motivational features and with a length of 28 pages. The 30-pages version "with ARCS" was different from this version in several ways: a) the pages contained symbols for highlighting important information (for stimulating attention), b) there were arguments why the text is important for the students, also teaching objectives, and examples within the texts were related to the life and personal experiences of the students (for stimulating relevance), c) students were told that individual effort is essential for learning and they got summaries as learning aids (for stimulating confidence), and d) students were praised for their progress within reading the text (for stimulating satisfaction).

SOE were measured by the corresponding PMI (Potsdamer Motivations-Inventar)-items (Rheinberg & Wendland, 2001), on a 5-point-Likert-scale (from "totally true" to "not at all true"): "I do not need any activity for research design because I understand everything at once". "When I am learning research design, then everything is clear to me, I do not need any effort". "I am excellent in research, even when I do not prepare for it". "I do not need to learn anything for research design, because I can solve relevant tasks automatically". Items reached high reliability (Cronbach´s Alpha for the pre-test 0.84 and for the final test 0.88). AOE were measured with the related subscale from the PMI (Cronbach´s Alpha for the pre-test 0.56 and for the final test 0.65). The following items were used: "When I work hard on research design tasks, then I am able to succeed". "Even when I am trying hard to solve research design tasks, I have the chance to become a real expert". "Whether I am successful or not successful in research design tasks, depends on the effort which I invest". Measuring the concept of OCE reached also acceptable reliability (0.69 and 0.74) and consisted of the following PMI-items: "Whether I am good or bad in research design, has no consequences for me". "I must have success with tasks on research design, because otherwise I will not get anything which is important to me". "Doing research design, I realize how I can handle and understand difficult matters more and more successfully". "Whether I am successful with research design tasks or not, is not relevant to me personally". Perceived incentive of action (PIA) was measured with five PMI-items (Cronbach´s Alpha for the final test = 0.70): "All that has to be done for research design, is boring to me". "To deal with research design tasks, is one of the most terrible things for me". "It is one of my wishes not to deal with research design tasks". "To work on research design tasks, makes fun to me". "During solving research design tasks, it is funny to see how I improve more and more". The measurement of perceived action control (PAC, Cronbach´s Alpha for the final test = 0.72) was based on four PMI-items: "When I am working on research design tasks, I have the feeling that I want to do exactly this kind of tasks". "I would never do research design tasks by my own voluntarily". "I am only working on research design tasks, in order that nobody can accuse me". "I would even solve research design tasks, even when I would not get any credits for it". Personal evaluation of the learning process was based on measuring personal experience and preference. Personal experience (PER1) was measured with one item: "This experience showed to me that I am able to learn well with instructional texts. (yes or no)". The measurement of personal preference (PER2) was also based on one item: "With other instructional materials I would have learned (better) or (equally well) or (worse)". The first knowledge test consisted of 8 items (Cronbach´s Alpha = 0.55), the second knowledge test of 13 items (Cronbach´s Alpha = 0.58). The final knowledge test consisted of 40 items with an average probability of success of 0.63 and correlated significantly with the average study grades of students ($r=0.37$, $p<0.004$). All knowledge tests measured skills in research design. Here are two examples of the test items: "Results of a study have internal validity when a) the results can be generalized, b) the effect observed within the dependent variable can conclusively be linked with the independent variable, c) when there are no alternative explanations for the results, or d) when b) and c) are correct". "When you have a research design with no randomization, no pre-testing, and only one post-test for each experimental and control group, then which factor may disturb the results? (history, testing, selection, or maturation).

Results

Table 1 shows the correlations between different measures of self-regulated learning. First, it can be seen that SOE and AOE in their pre- and final tests are highly correlated with each other (.50 < r > .22) meaning that high AOE correspond with high SOE: Learners who expect that they will have success in a task also expect that the situation itself, without any action, will lead to the desired outcome. OCE did not correlate significantly with SOE and AOE: The expectancies that a certain outcome will lead to certain consequences are irrespective of which SOE or AOE were given. Also, the results showed that high AOE and high OCE corresponded with high perceived incentive of action (r = 0.42 and r = 0.26), when measurement was undertaken after learning. However, in the pre-test stage, perceived incentives of action were intensively correlated with SOE and AOE (r = 0.44 and r = 0.43). A quite similar relationship was found for perceived action control which correlated, in the pre-test version, positively with all measured expectancies and perceived incentive of action (0.72 >= r => 0.22). When perceived action control was measured after learning, then only perceived incentive of action and OCE were correlated positively (0.60 >= r => 0.24). Other results showed that the quality of personal experience did not correlate with any of the expectancies and perceptions (0.14 >= r => 0.24). However, high personal preference corresponded with high AOE, high perceived incentive of action, and high personal experience (r = -0.30, r = -0.21, r = -0.56). In respect to knowledge acquisition, it was found that none of the motivational variables correlated significantly with the first knowledge acquisition test (0.17 >= r => 0.01). The higher the perceived incentive of action (in the pre-test) and the higher the personal preference for the learning activity, the more tasks were solved successfully within the second knowledge acquisition test (r = -0.20, r = 0.21). The final test result was correlated with perceived action control (measured after learning) with r = 0.29. All measured variables were correlated when measured at different times (pre-test and final test) (0.31 >= r => -0.56), only the first knowledge test did not correlate with the final test (r = 0.06).

Table 1

Correlations of Different Measures of Self-Regulated Learning (51 < n < 76)

Measures	SOE-P	SOE-T	AOE-P	AOE-T	OCE-P	OCE-T	PIA-P	PIA-T	PAC-P	PAC-T	PER-1	PER-2	KNO-1	KNO-2	KNO-3
SOE-P	1														

Mea-sures	SOE-P	SOE-T	AOE-P	AOE-T	OCE-P	OCE-T	PIA-P	PIA-T	PAC-P	PAC-T	PER-1	PER-2	KNO-1	KNO-2	KNO-3
SOE-T	.50**	1													
AOE-P	.47**	.22*	1												
AOE-T	.29**	.28**	.42**	1											
OCE-P	.09	.15	.04	-.11	1										
OCE-T	.06	-.03	.01	.08	.52**	1									
PIA-P	.44**	.29**	.43**	.25*	.08	.13	1								
PIA-T	.17	.17	.07	.42**	.08	.26*	.56**	1							
PAC-P	.37**	.22*	.41**	.24*	.25*	.35**	.72**	.50**	1						
PAC-T	.03	.18	.11	.11	.16	.24*	.49**	.60**	.49**	1					
PER1-T	.07	.00	.07	.14	-.15	-.17	.14	.10	.05	.05	1				
PER2-T	-.01	-.05	-.03	-.30**	-.03	-.09	-.05	-.21*	-.13	-.05	-.56**	1			
KNO1	.05	-	.05	-	.17	-	.01	-	.06	-	-	-	1		
KNO2	-.02	-.13	-.10	-.19	.02	.11	-.20*	-.15	-.08	.07	-.12	.21*	.44**	1	
KNO3	-.03	-.13	.20	.02	.05	.04	.08	-.04	.08	.29*	.06	.06	.06	.31**	1

Note. P = Pretest, T = Test; SOE = Situation-Outcome-Expectancy, AOE = Action-Outcome-Expectancy, OCE = Outcome-Consequence-Expectancy, PIA = Perceived Incentive of Action, PAC = Perceived Action Control, PER1 = Personal Experience, PER2 = Personal Preference, KNO = Knowledge Acquisition; ** p < 0.01, * p < 0.05 (1-tailed). "-" indicating irrelevant correlations, because final tests (-T) were taken after the first test for knowledge acquisition (KNO1).

Table 2 shows the effects of implementing the ARCS-strategies on different measures of self-regulated learning. Considering only final tests and the different scale directions of measurement, ARCS-strategies leaded to significantly lower SOE, lower perceived incentive of action and perceived action control, to better personal experience, and lower knowledge acquisition when first measured (p(1-tailed) =< 0.05). Implementing ARCS-strategies had no significant influence on AOE, OCE, and the two final knowledge acquisition tests (p(1-tailed) => 0.152). As some of the dependent variables were correlated and in order to prevent from Alpha-inflation, a multi-variate analysis of variance (MANOVA) was computed. MANOVA based on all dependent variables showed a significant overall effect for ARCS-strategies (F = 2.074, p =< 0.05, R^2 = 0.35). Uni-variate analysis of variance showed similar significant effects in comparison with the t-tests, except for personal preference (F = 1.523, p = 0.223) and the first knowledge acquisition test (F = 0.660, p = 0.421).

Table 2

Effects of ARCS-Strategies on Different Measures of Self-Regulated Learning

Measures	Without ARCS			With ARCS			p
	M	SD	n	M	SD	n	
SOE-T	17.41	2.77	39	18.53	1.80	34	*
AOE-T	6.23	2.21	39	6.81	2.60	36	
OCE-T	12.84	3.82	38	13.50	3.20	36	
PIA-T	12.32	2.92	38	14.26	3.31	35	**
PAC-T	11.49	3.24	39	13.22	3.38	36	*
PER1-T	1.30	0.46	37	1.12	0.33	34	*
PER2-T	1.51	0.51	37	1.75	0.44	32	*
KNO1	4.82	1.73	39	4.03	1.81	36	*
KNO2	8.15	2.63	39	7.75	2.39	36	
KNO3	25.06	6.33	31	25.69	4.90	26	

Note. ** p < 0.01, * p < 0.05 (1-tailed).

Discussions

Within the presented study, different motivational variables relevant for self-regulated learning were measured, related to each other and observed in their change resulting from instructional interventions which were based on the ARCS-approach. Correlations between pre- and post-test measurements of expectancies, perceived incentives, and perceived action control differed considerably. This circumstance indicates that motivational variables and their relationships to other variables change during self-regulated learning: Although all pre- and post-test measurements of the same variables are highly correlated, their relationships with other variables vary at large scale when pre-tests were compared with final tests. A possible explanation for this result might be that during self-regulated learning, learners sharpened their view of the uniqueness of single motivational variables. Whereas pre-tests measured in a broader sense attitudes, i.e., common general expectancies and values, final tests measures were more built on specific learning experiences. Such specific experiences reduced or changed correlations based on underlying common attitude patterns previously contained in the pre-tests. As a conclusion from this explanation, it can be recommended that motivational variables of self-regulated learning should be measured at the beginning, during, and at the end of the learning process.

Another result concerns the missing of or low correlations of expectancies, incentives, and perceived action control with personal evaluations of the learning process or with knowledge acquisition. An explanation for this result could be that motivational variables were not triggered frequently or intensively enough in order to influence learning significantly. This missing activation of motivational variables might be especially a problem for self-regulated learners which are not motivated by external factors, but depend on their own ability to self-motivate. Problems with motivation should be handled with more attention especially in learning environments controlled by a learner.

In respect to the ARCS-strategies, it was found that they had positive influences on SOE, and the personal evaluations of the learning process in respect to experience and preference, and negative influences on incentives, perceived action control, and the result of the first knowledge acquisition test. Especially, the negative motivational effects of implementing the ARCS-strategies need further attention. Students which learned with the text containing ARCS-strategies showed significantly less knowledge acquisition within the first test compared to students which learned the text without ARCS-strategies. However, within the second knowledge acquisition test, these differences were not significant, and considering the third test, it was observed that students with the ARCS-text showed, in tendency, better learning results than the other group of students without ARCS-strategies. So, it can be concluded that the negative ARCS-effects on learning disappear when a long-term perspective is considered. The negative results at the first test might be due to the fact that the ARCS-text took more time for learning, because implementing the ARCS-strategies into the text increased the length of the text body by about 5 percent. ARCS-strategies also had negative effects on perceived incentive values. This result represents no shortcoming of the ARCS-approach, as this approach also contains strategies for enhancing the perception of incentives. However, within the presented study, these strategies were not implemented, because applying such strategies needs a considerable effort in instructional design activities which were not available at this time. Future research activities should concentrate on the question of how instructional texts can include motivating incentives presented only by textual information. The negative effect of ARCS-strategies on perceived action control can be explained by assuming that the additional instructional strategies disturbed learners in their action control. Additional instructional strategies might increase cognitive load, so that necessary cognitive resources for successful action control were not sufficiently available. When this explanation is true, then future research must deal with the question of how additional instructional strategies must be designed and implemented without increasing cognitive load and therefore risk to decrease cognitive resources for learning.

Based on this problem, two main aspects will be important for future research and instructional design, one, questions dealing with the phenomenon of "seductive details" (Harp & Mayer, 1998), and one with "motivationally adaptive" mechanism (Song & Keller, 2001). "Seductive details", i.e., interesting, but irrelevant adjuncts in instructional texts, distract a learner or disrupt the coherence of a learning process. It has to be clarified in future research to what extent ARCS-strategies are seductive and how ARCS-strategies can be implemented in texts without producing the risk of being seductive. A second main research question should deal with the issue of how instructional texts can be made "adaptive" to different types of learners and their needs. An educationally acceptable degree of adaptivity can relatively easily be accomplished in teacher- and computer-based instruction, e.g., by sequencing instruction based on pre-tests, but it is hard to achieve in self-regulated learning with pre-prepared instructional texts. Keller and Kopp (1987) showed a method of how ARCS-strategies can be implemented within instructional texts, but without addressing the important question of adaptivity. An aspect of adaptivity within instructional texts can relatively easily be realized by using exercises and questions with different task difficulties (Astleitner & Keller, 1995). However, task difficulty is also an important variable in supporting learning and knowledge acquisition. In that respect, strategies for presenting and selecting tasks with varying difficulties have to be found which assist each other in a complementary manner: Both, supporting cognitive learning and stimulating motivation must be achieved.

Overall, much more research is needed, in order to know more about the right number and frequency of motivationally effective instructional strategies, about their capacity to motivate different types of learners, about the intensity and duration of effects, and especially about their relevance in self-regulated learning scenarios based on instructional texts.

References

Astleitner, H., & Keller, J. M. (1995). A model for motivationally adaptive computer-assisted instruction. Journal of Research on Computing in Education, 27, 270-280.

Bellon, T., & Oates, R. (2002). Best practices in cyberspace. Motivating the online learner [WWW document]. URL http://ccenter.uoregon.edu/conferences/necc2002/program/presenter_rp_pdfs/bellon.pdf

Campbell, D. T., & Russo, M. J. (1999). Social experimentation. Thousand Oaks, CA: Sage.

Chang, M. M., & Lehman, J. (2001). Making web-based instruction more relevant. Lessons from a research study [WWW document]. URL http://www.calumet.purdue.edu/todl/proceedings/2001/2001papers/chang.PDF

Chyung, Y., Winiecki, D., & Fenner, J. A. (1999). Evaluation of effective interventions to solve the dropout problem in adult distance education [WWW document]. URL http://coen.boisestate.edu/ychyung/edmedia.htm

Harp, S. F., & Mayer, R. E. (1998). How seductive details do their damage. A theory of cognitive interest in science learning. Journal of Educational Psychology, 90, 414-434.

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), Instructional-design theories and models. An overview of their current status (pp. 383-434). Hillsdale, NJ: Erlbaum.

Keller, J. M. (1997). Motivational design and multimedia. Beyond the novelty effect. Strategic Human Resource Development Review, 1, 188-203.

Keller, J. M. (1999). Motivation in cyber learning environments. International Journal of Educational Technology, 1, 7-30.

Keller, J. M., & Kopp, T. W. (1987). An application of the ARCS model of motivational design. In C. M. Reigeluth (Ed.), Instructional theories in action. Lessons illustrating selected theories and models (pp. 289-320). Hillsdale, NJ: Erlbaum.

Lee, S. H., & Boling, E. (1999). Screen design guidelines for motivation in interactive multimedia instruction. A survey and framework for designers. Educational Technology, 39, 19-26.

Malone, T. W., & Lepper, M. R. (1987). Making learning fun. A taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr (Eds.), Aptitude, learning, and instruction. Volume 3: Conative and affective process analyses (pp. 223-253). Hillsdale, NJ: Erlbaum.

Means, T. B., Jonassen, D. H., & Dwyer, F. M. (1997). Enhancing relevance. Embedded ARCS strategies vs. purpose. Educational Technology, Research & Development, 45, 5-17.

Rheinberg, F., & Wendland, M. (2001). Das Potsdamer Motivations-Inventar (PMI). Ein Fragebogen zur Erfassung fachspezifischer Lernmotivation. Poster presented at the 35. Jahrestagung der Gesellschaft für Didaktik der Mathematik, Ludwigsburg, March, 5th - 9th, 2001.

Rheinberg, F., Vollmeyer, R., & Rollet, W. (2000). Motivation and action in self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), Handbook of self-regulation (pp. 503-529). San Diego, CA: Academic Press.

Shellnut, B., Knowlton, A., & Savage, T. (1999). Applying the ARCS model to the design and development of computer-based modules for manufacturing engineering courses. Educational Technology, Research & Development, 47, 100-110.

Song, S. H., & Keller, J. M. (2001). Effectiveness of motivationally adaptive computer-assisted instruction on the dynamic aspects of motivation. Educational Technology, Research & Development, 49, 5-22.

Visser, L. (1998). The development of motivational communication in distance education support (Unpublished doctoral dissertation, University of Twente, The Netherlands).

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