Using Learning Journals to Increase Metacognition, Motivation, and Learning in Computer Information Systems Education

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Abstract

While regular reflection has been found to be a key practice in agile software development, the use of learning journals in computer information systems (CIS) education has yet to be studied systematically. Learning journals are writing-to-learn interventions that use writing as a medium to facilitate metacognition. A randomized controlled trial investigating the effects of learning journals on metacognition, motivation, and learning was implemented in an undergraduate computer information systems course on web design. Students were randomly assigned to respond to five metacognitive writing prompts (learning journal condition) or five non-metacognitive writing prompts (control condition) over the course of ten weeks. Results suggest that while learning journals increase metacognitive awareness and intrinsic motivation, they do not affect learning directly. A post-hoc quantitative content analysis of the learning journals found that certain linguistic dimensions are associated with higher metacognition, motivation, and learning. While students' use of assent and informal words in learning journals is positively correlated with metacognitive awareness and intrinsic motivation, their use of differ words is negatively correlated with metacognitive awareness, intrinsic motivation, and final grades. Hence, instructors should implement learning journals and consider targeted coaching to help students achieve greater metacognition, motivation, and learning.

Keywords: learning journals, metacognition, motivation, learning

1. INTRODUCTION

Agile software development emphasizes regular reflection in order to enable continuous learning (Nerur & Balijepally, 2007). Reflective practice helps developers determine if and to what extent processes should be expanded, adapted, altered, or abandoned (Hoda, Babb, Nørbjerg, 2013). In fact, the Reflective Agile Learning Model provides specific guidelines for embedding self-reflection into an agile software development cycle through reflection-in-action and reflection-on-action (Babb, Nørbjerg, Hoda, 2014). While reflection-in-action emphasizes reflecting on an incident while it occurs, reflection-on-action emphasizes reflecting on an incident after it occurred (Schön, 1984). Reflection-on-action may involve reflective writing in the form of journal entries.

In the context of computer information systems (CIS) education, students can be encouraged to engage in reflection-on-action through learning journals. Learning journals are writing-to-learn interventions that use writing as a medium to facilitate metacognition (Cooper, 2006). Metacognition is the ability to understand and control one's own learning processes (Schraw & Dennison, 1994). It has been shown to be an important predictor of academic success (Pintrich, 2002) that can be learned and further developed (White & Frederiksen, 1998). A significant amount of research on learning journals has produced mixed findings, suggesting that their effectiveness is highly context-dependent (Bangert-Drowns, Hurley, & Wilkinson, 2004). Only few studies have evaluated learning journals in business disciplines (e.g. Cathro, O'Kane, & Gilbertson, 2017) and

their effectiveness has yet to be empirically validated in the context of CIS education.

To help address this gap, the present research evaluates the effectiveness of learning journals in increasing metacognition, motivation, and learning through a randomized controlled trial in an undergraduate CIS course on web design.

2. BACKGROUND

The importance of writing for learning has been explored at least since the early 1970s (Emig, 1977). Early work focused on proposing general arguments without explicating and testing the mechanisms by which learning might be enhanced through writing-to-learn interventions (Ackerman, 1993). Subsequent research in the 1980s began to define and disentangle the effects of various contextual factors, such as the specific nature of the writing prompts (Durst & Newell, 1989). Since then, a large number of studies have focused on the conditions under which writing appears to facilitate learning. In particular learning journals, which are writing tasks that foster beneficial metacognitive learning strategies, have been widely studied in the context of higher education (Langer, 2002).

However, a comprehensive meta-analysis of research on learning journals found considerable variation in their effect on metacognition, motivation, and learning (Bangert-Drowns, Hurley, & Wilkinson, 2004). Moderators that were identified to potentially influence effectiveness include the overall treatment length, amount of time spent writing, and use of metacognitive reflection prompts. Surprisingly, longer writing assignments were found to be counterproductive in classroom contexts. Taken together, these findings suggest that effective learning journals tend to be semester-long assignments using metacognitive reflection prompts that can be completed in less than 10 minutes.

The present work empirically validates these recommendations through a randomized controlled trial in an undergraduate CIS course. It was hypothesized that students who maintain a learning journal over the course of the semester will subsequently exhibit greater metacognition (H1), motivation (H2), and learning (H3), than students who do not maintain a learning journal. Figure 1 depicts the research model.

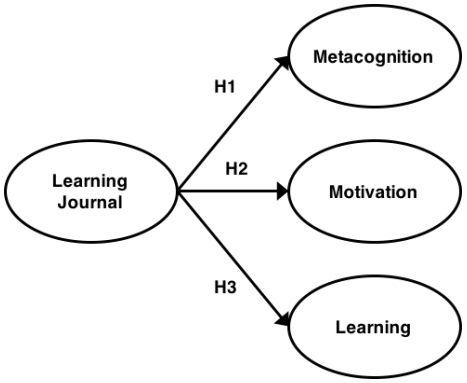

Figure 1. Research Model

3. METHODOLOGY

A randomized controlled trial was implemented in three sections of CIS 267 (HTML & CSS), which was taught at Quinnipiac University in Fall 2016 (N = 98). CIS 267 is an undergraduate elective CIS course that places a heavy emphasis on experiential, hands-on learning through weekly coding projects.

At the beginning of the semester, all students completed a pre-test survey measuring demographic factors, previous knowledge ("What is your knowledge of HTML and CSS?" anchored at 1: None at all and 5: A great deal), and learning style (LSI; Kolb & Kolb, 2005). Students were asked to complete a journal writing assignment every two weeks for ten weeks of the semester, totaling five journal entries. Students were randomly assigned to one of two treatment conditions, which determined the content of their journal writing assignment.

Table 1. Writing Prompt Used in Learning Journal Condition

Please create a post about the coding projects you completed in this course so far. Specifically, please write one short paragraph for each of the following questions:
1. What are the similarities/differences between the coding projects?
2. What was the ideal strategy for completing the coding projects?
3. *What will you do differently when working on coding projects in the future?*

In the learning journal condition, the journal writing assignment consisted of a prompt that was meant to facilitate metacognition. The prompt was designed following an established metacognitive questioning strategy (Mevarech & Kramarski, 1997). Table 1 shows the

metacognitive writing prompt that was used in the learning journal condition.

In the control condition, the journal writing assignment consisted of a prompt that was unrelated to metacognition. The specific prompt used in the control condition can be found in Table 2 below.

Table 2. Writing Prompt Used in Control Condition

Please create a post about a website that has won the "Site of the Day" award from AWWWARDS. Choose one website from which you would possibly like to incorporate one or more design elements into your final project. Please write one short paragraph for each of the following questions:

1. *Which website did you choose and why?*
2. *What design element(s) would you possibly like to incorporate into your final project and why?*
3. *Judging by the websites you saw while browsing the awards, how common are the design element(s) that you chose?*

Over the course of ten weeks, each student answered the same prompt a total of five times, i.e. students in the learning journal condition answered the writing prompt that was meant to facilitate metacognition every two weeks and students in the control condition answered the writing prompt that was unrelated to metacognition every two weeks. At the end of the semester, all students completed a post-test survey measuring metacognitive awareness (Schraw & Dennison, 1994) and intrinsic motivation (McAuley, Duncan, & Tammen, 1987). Students' final grades were used as a measure of learning. Final grades were calculated based on students' performance in weekly coding projects (weighted 70%), a final project (weighted 15%), a final paper, class participation, and the journal assignments (each weighted 5%). Thus, the research employs a single factor (learning journal vs. control) between subjects experimental design.

4. RESULTS

Demographics and Randomization

A total of N = 98 students participated in the study. Detailed demographics of the sample are presented in Table 3.

Table 3. Sample Demographics

Gender	
Male	70 (71%)
Female	28 (29%)
Class Level	
Freshman	0 (0%)
Sophomore	12 (12%)
Junior	34 (35%)
Senior	52 (53%)

Forty-nine (50%) students were assigned to each treatment condition. Multiple independent-samples t-tests were conducted to evaluate if the assignment of students to conditions was random with regards to gender, class level, previous knowledge, and learning style. Neither gender nor class level was different between treatment conditions (t < 1.22, p > .1). Previous knowledge was relatively low (M = 2.00, SD = .76) and also not different between conditions (t = -1.38, p > .1). Learning style was measured using summative dimension values of the LSI (Kolb & Kolb, 2005). Students exhibited a diverging learning style, which is characterized by an emphasis of Concrete Experience (M = 36.11, SD = 4.91) over Abstract Conceptualization (M = 29.47, SD = 5.55) and Reflective Observation (M = 30.27, SD = 5.79) over Active Experimentation (M = 24.15, SD = 5.26). No significant differences of LSI values between conditions were observed (t < 1.69, p > .1). This learning style profile appears to be common among undergraduate CIS students at Quinnipiac University, as it mirrors the results obtained in a previous, unrelated study (Lang, 2017). The students' aggregate learning style profile is shown in Figure 2.

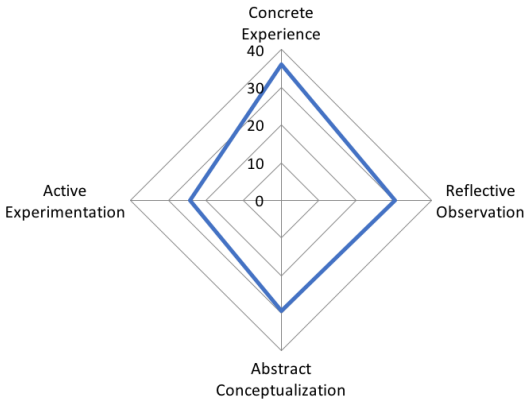

Figure 2: Learning Style Profile

These findings suggest that the assignment of students to conditions was indeed random with regards to gender, class level, previous knowledge, and learning style.

Moreover, multiple independent-samples t-tests were conducted to evaluate the randomness of missing values in the pre- and post-test surveys as well as the journal writing assignments. A total of 18 students had at least one missing value in the pre-test survey, post-test survey, or journal writing assignments. No significant differences emerged (all *t*s < .65, *p*s > .52), suggesting that missing values were indeed randomly occurring.

The writing prompts for both treatment conditions were designed to elicit the same amount of writing. Overall, students in both treatment conditions wrote journal entries of comparable length, as measured by word count (see Table 4). Likewise, journal entries in both treatment conditions exhibited a declining trend in terms of word count over time. Thus, any observed differences in the dependent variables cannot be attributed to differences in the amount of writing between treatment conditions.

Taken together, these results indicate that the random assignment of students to treatment conditions was successful and that students' behavior across treatment conditions was comparable with regards to missing responses and the length of journal entries.

Table 4. Word Count of Journal Entries

	Learning Journal Condition	*Control Condition*	*Difference*
Entry 1	209.32 (78.68)	229.23 (116.86)	19.91^{ns}
Entry 2	169.69 (64.68)	183.28 (104.68)	13.59^{ns}
Entry 3	150.37 (48.79)	175.15 (113.78)	24.77^{ns}
Entry 4	156.01 (54.49)	171.97 (85.87)	15.96^{ns}
Entry 5	147.95 (54.37)	170.85 (88.27)	22.90^{ns}
Total	833.34 (301.01)	930.48 (509.47)	97.14^{ns}

^{ns} $p > .1$

Dependent Variables

The data were analyzed using partial least squares path modeling in R (plspm package version 0.4.9). A two-step approach based on the recommendations by Henseler, Hubona, and Ray (2016) was used: First, the reliability and validity of the measurement model was established. Based on previous research (Teo & Lee, 2012), metacognitive awareness was modeled using two factors: knowledge about cognition (MA-K) and regulation of cognition (MA-R). Likewise, intrinsic motivation (IM) was modeled using a single factor (Monteiro, Mata, and Peixoto, 2015). Final grade was modeled as a single-item factor. Likewise, learning journal was modeled as a single-factor using a dummy variable (*0: Control condition, 1: Learning journal condition*). Items with factor loadings of .40 or less and items with higher cross-loadings on other factors were removed from further analysis. As a result, the final measurement model exhibits adequate reliability and validity (all Dillon-Goldstein's *ρ*s > .84, Cronbach's *α*s > .78). Detailed results supporting the reliability and validity of the measurement model can be found in Appendix A.

Next, the path coefficients of the model were evaluated using a bootstrapping method with 100 samples. The results support most of the hypothesized effects: At the end of the semester, students in the treatment condition exhibited greater knowledge about cognition than students in the control condition (β = 0.25, p < .05). Moreover, students in the treatment condition showed greater regulation of cognition than students in the control condition (β = 0.25, p < .05). Likewise, students in the treatment condition had higher intrinsic motivation than students in the control condition (β = 0.22, p < .05). However, no difference in final grades between students in the treatment and control conditions was observed (β = 0.01, p > .1). Thus, H1 and H2 are supported, while H3 is not supported. Figure 3 shows the results of the path analysis.

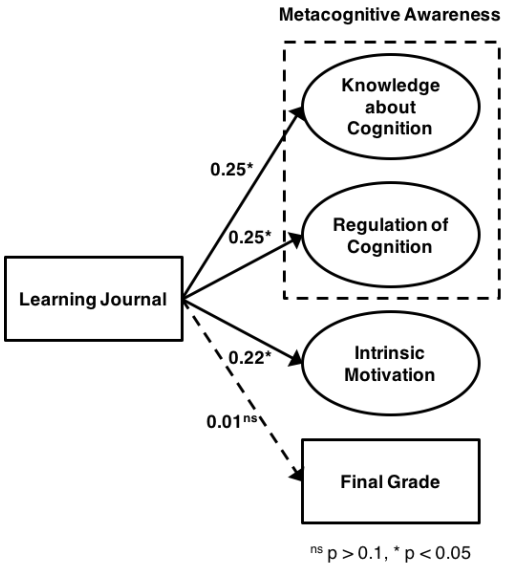

Figure 3. Results

Taken together, these findings provide evidence that learning journals increase metacognition and motivation.

Post-Hoc Quantitative Content Analysis

A post-hoc quantitative content analysis of the learning journals was performed in order to shed light on the potential mechanisms underlying the observed effects. The Linguistic Inquiry and Word Count (LIWC) software (Pennebaker et al., 2015) was used to quantitatively analyze the learning journal content. The LIWC software compares words against a comprehensive dictionary and counts the percentage of words that reflect different emotions, thinking styles, social concerns, and other psychologically-relevant categories (Tausczik & Pennebaker, 2010).

The LIWC software generated data for each journal entry across 93 linguistic dimensions. The linguistic dimensions were subsequently entered into separate correlation analyses with the scaled factor scores for each of the dependent variables: both subscales of metacognitive awareness, i.e. knowledge about cognition (MA-K) and regulation of cognition (MA-R), intrinsic motivation (IM), and final grade (Grade). Three linguistic dimensions had several significant correlations with the dependent variables, as shown in Table 5.

Table 5. Correlations between Linguistic Dimensions and Dependent Variables

	MA-K	*MA-R*	*IM*	*Grade*
Assent	.34*	.27†	.27†	.06ns
Differ	-.20ns	-.29*	-.41**	-.32*
Informal	.19ns	.32*	.27†	-.04ns

ns $p > .1$, † $p < .1$, * $p < .05$, ** $p < .01$

The linguistic dimension of "assent," which includes words such as "absolutely," "agree," and "alright," was positively correlated with knowledge about cognition ($r = .34$, $p < .05$), regulation of cognition ($r = .27$, $p < .1$), and intrinsic motivation ($r = .27$, $p < .1$). This suggests that students who wrote learning journals using more assent words exhibited greater knowledge about cognition, regulation of cognition, and intrinsic motivation than students who wrote learning journals using less assent words.

The linguistic dimension of "differ," which includes words such as "actually," "although," and "despite," was negatively correlated with regulation of cognition ($r = -.29$, $p < .05$), intrinsic motivation ($r = -.41$, $p < .01$), and final grade ($r = -.32$, $p < .05$). This result indicates that students who wrote learning journals using more differ words had lower regulation of cognition, intrinsic motivation, and final grades than students who wrote learning journals using fewer differ words.

Lastly, the linguistic dimension of "informal," which includes words such as "badass," "cool," and "geeky," was positively correlated with metacognitive awareness (again, although correlations with both subscales were positive, only the correlation with regulation of cognition ($r = .32$, $p < .05$) and intrinsic motivation ($r = .27$, $p < .05$). This finding suggests that students who wrote learning journals using more informal words subsequently showed higher regulation of cognition and intrinsic motivation than students who used less informal words in their learning journals.

Table 6 provides additional examples for each of the three linguistic dimensions.

Table 6. Examples for Linguistic Dimensions

Dimension	*Examples*
Assent	absolutely, agree, alright, indeed, yes
Differ	actually, although, despite, however, otherwise
Informal	badass, cool, geeky, kinda, sucks

Taken together, the results of the post-hoc quantitative content analysis suggest that linguistic dimensions in learning journals may affect metacognition, motivation, and learning. In particular, the use of assent and informal words may increase metacognitive awareness and intrinsic motivation, while the use of differ words may decrease metacognitive awareness, intrinsic motivation, and final grades.

5. DISCUSSION

The results of the randomized controlled trial lend support to the hypotheses that learning journals increase metacognition (H1) and motivation (H2). However, the relationship between learning journals and learning (H3) is not as straight forward, as no direct effect has been observed. Although relatively small in size, these effects were found after random assignment of students to treatment conditions, which suggests that they hold across different genders, class levels, levels of previous knowledge, and learning styles. Since students were asked to reflect upon their learning every two weeks for a total of ten weeks, it is likely that the regular practice of metacognition combined with the focus on self-help and

continuous improvement, ultimately helped students increase their metacognition and motivation.

The post-hoc analysis focusing on linguistic dimensions of the learning journals indicates that assent and informal words may have the potential to magnify these effects, while differ words may play an attenuating role. Stated differently, on the one hand, learning journals that focused on positive insights with which students agreed and that used informal language were associated with higher levels of metacognitive awareness and intrinsic motivation. On the other hand, learning journals that focused on contrasting insights with disagreement were associated with lower levels of metacognitive awareness, intrinsic motivation, and final grades.

The implications of these findings for CIS instructors are two-fold: First, instructors are well-advised to incorporate learning journals into their classes. Although learning journals are not a silver bullet to increase learning, they increase metacognition and motivation. Given the numerous benefits of increasing metacognition and motivation for students inside and outside the classroom, the additional work required in administering and grading these assignments appears to be worth the effort. Second, instructors should consider guiding students in their learning journal writing to focus on positive insights with which they agree, while encouraging the use of informal language. This could be accomplished through targeted coaching and feedback for students.

However, the results of this study, along with its implications, must be viewed in light of the limitations of this study. First, the relatively small sample (N = 98) may have been composed of students that were predisposed to react favorably to a learning journal assignment. Second, the fact that the experiment relied solely on CIS students in a web design class may have accidentally enhanced the effectiveness of the learning journal treatment. Third, the specific writing prompts used in the treatment conditions were unique to the subject matter and may not be easily transferable to other CIS courses. Fourth, alternative measures of the dependent variables are available, which may alter the reported effects. Finally, the post-hoc analysis was correlational in nature, which implies that the use of linguistic dimensions may also be the outcome – and not the cause – of higher metacognition and motivation.

Given the shortcomings of this study, additional research is needed to further support its implications. In particular, future research should consider investigating the effects of different metacognitive learning journal prompts, as well as the effects of learning journal coaching strategies in CIS classes.

6. CONCLUSION

Regular reflection is a key component of agile software development. However, learning journals, which are writing-to-learn interventions aimed at increasing metacognition, have hitherto not been systematically investigated in the context of CIS education. Previous research on the effectiveness of learning journals in other disciplines has found mixed results. Moreover, little attention has been given to the effectiveness of learning journals in business and engineering disciplines in general, and CIS in particular. To fill this gap, a randomized controlled trial investigating the impact of learning journals on metacognition, motivation, and learning was conducted in three sections of an undergraduate CIS elective course on web design (N = 98).

The findings suggest that while learning journals increase metacognitive awareness and intrinsic motivation, they do not directly affect final grades. A post-hoc quantitative content analysis further suggests that certain linguistic dimensions of the learning journals may differentially affect these dependent variables. In particular, the use of assent and informal words may increase metacognitive awareness and intrinsic motivation, while the use of differ words may decrease metacognitive awareness, intrinsic motivation, and final grades. Given the benefits of increased metacognition and motivation for students, CIS instructors should integrate learning journals into their classes. However, future research should investigate the effects of different metacognitive prompts and coaching when implementing learning journals in CIS courses.

7. REFERENCES

Ackerman, J. M. (1993). The Promise of Writing to Learn. *Written Communication*, *10*(3), 334-370.

Babb, J., Nørbjerg, J., & Hoda, R. (2014). Embedding Reflection and Learning into Agile Software Development. *IEEE Software, 31*(4), 51-57.

Bangert-Drowns, R. L., Hurley, M. M., & Wilkinson, B. (2004). The Effects of School-

Based Writing-to-Learn Interventions on Academic Achievement: A Meta-Analysis. *Review of Educational Research, 74*(1), 29-58.

Cathro, V., O'Kane, P., & Gilbertson, D. (2017). Assessing Reflection: Understanding Skill Development Through Reflective Learning Journals. *Education + Training, 59*(4), 427-442.

Cooper, J. W. (2006). At Issue: Journal Writing in Career and Technical Education: A Tool to Promote Critical Thinking Skills. *Journal of STEM Teacher Education, 43*(2), Article 7.

Durst, R. K., & Newell, G. E. (1989). The Uses of Function: James Britton's Category System and Research on Writing. *Review of Educational Research, 59*(4), 375-394.

Emig, J. (1977). Writing as a Mode of Learning. College *Composition and Communication*, 28, 122-12.

Henseler, J., Hubona, G., & Ray, P. A. (2016). Using PLS Path Modeling in New Technology Research: Updated Guidelines. *Industrial Management & Data Systems, 116*(1), 2-20.

Hoda, R., Babb, J., & Nørbjerg, J. (2013). Toward Learning Teams. *IEEE Software, 30*(4), 95–98.

Kolb, A. Y., & Kolb, D. A. (2005). The Kolb Learning Style Inventory—Version 3.1 2005 Technical Specifications. Department of Organizational Behavior, Weatherhead School of Management, Case Western Reserve University, Cleveland, OH.

Lang, G. (2017). Agile Learning: Sprinting Through the Semester. *Information Systems Education Journal, 15*(3), 14-21.

Langer, A. M. (2002). Reflecting on Practice: Using Learning Journals in Higher and Continuing Education. *Teaching in Higher Education, 7*(3), 337-351.

McAuley, E., Duncan, T., & Tammen, V. V. (1987). Psychometric Properties of the Intrinsic Motivation Inventory in a Competitive Sport Setting: A Confirmatory Factor Analysis. *Research Quarterly for Exercise and Sport*, 60, 48-58.

Mevarech, Z. R., & Kramarski, B. (1997). IMPROVE: A Multidimensional Method for Teaching Mathematics in Heterogeneous Classrooms. *American Educational Research Journal*, 34, 365-395.

Monteiro, V., Mata, L., & Peixoto, F. (2015). Intrinsic Motivation Inventory: Psychometric Properties in the Context of First Language and Mathematics Learning. *Psychology/ Psicologia Reflexao e Critica, 28*(3), 434-443.

Nerur, S., & Balijepally, V. (2007). Theoretical Reflections on Agile Development Methodologies: The Traditional Goal of Optimization and Control is Making Way for Learning and Innovation. *Communications of the ACM, 50*(3), 79–83.

Pennebaker, J. W., Booth, R. J., Boyd, R. L., & Francis, M. E. (2015). Linguistic Inquiry and Word Count: LIWC2015. Austin, TX: Pennebaker Conglomerates.

Schön, D. (1984). *The Reflective Practitioner: How Professionals Think In Action*. Basic Books: New York.

Schraw, G., & Dennison, R. S. (1994). Assessing Metacognitive Awareness. *Contemporary Educational Psychology*, 19, 460-475.

Tausczik, Y. R., & Pennebaker, J. W. (2010). The Psychological Meaning of Words: LIWC and Computerized Text Analysis Methods. *Journal of Language and Social Psychology, 2*(9), 24-54.

Teo, T., & Lee, C. (2012). Assessing the Factorial Validity of the Metacognitive Awareness Inventory (MAI) in an Asian Country: A Confirmatory Factor Analysis. *International Journal of Educational and Psychological Assessment, 10*(2), 92-103.

White, B. Y., & Frederiksen, J. R. (1998). Inquiry, Modeling, and Metacognition: Making Science Accessible to All Students. *Cognition and Instruction*, 16, 3–118.

Editor's Note:

This paper was selected for inclusion in the journal as an EDSIGCON 2017 Meritorious Paper. The acceptance rate is typically 15% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2017.

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Appendix A: Survey Instruments

Table 7. Construct Descriptive and Reliability Measures

	Learning Journal	*MA-K*	*MA-R*	*IM*	*Final Grade*
Mean	0.49	5.83	5.25	6.07	94.64
SD	0.50	0.60	0.87	0.59	8.51
AVE	1.00	0.30	0.42	0.43	1.00
ρ	1.00	0.84	0.96	0.91	1.00
α	1.00	0.78	0.95	0.88	1.00

Table 8. Inter-Construct Correlations

	Learning Journal	*MA-K*	*MA-R*	*IM*	*Final Grade*
Learning Journal	1.00				
MA-K	0.25	1.00			
MA-R	0.25	0.64	1.00		
IM	0.22	0.45	0.29	1.00	
Final Grade	0.01	0.18	0.27	0.32	1.00

Table 9. Item Loadings for Regulation of Cognition (MA-R) Scale

Item	*Loading*
I pace myself while learning in order to have enough time.	0.66
I think about what I really need to learn before I begin a task.	0.63
I set specific goals before I begin a task.	0.61
I ask myself questions about the material before I begin.	0.74
I think of several ways to solve a problem and choose the best one.	0.74
I read instructions carefully before I begin a task.	0.49
I organize my time to best accomplish my goals.	0.51
I slow down when I encounter important information.	0.59
I consciously focus my attention on important information.	0.71
I focus on the meaning and significance of new information.	0.62
I create my own examples to make information more meaningful.	0.54
I try to translate new information into my own words.	0.58
I use the organizational structure of the text to help me learn.	0.57
I ask myself if what I'm reading is related to what I already know.	0.62
I ask myself periodically if I am meeting my goals.	0.62
I consider several alternatives to a problem before I answer.	0.63
I ask myself if I have considered all options when solving a problem.	0.82
I periodically review to help me understand important relationships.	0.71
I find myself analyzing the usefulness of strategies while I study.	0.77
I find myself pausing regularly to check my comprehension.	0.69
I ask myself questions about how well I am doing while learning something new.	0.74
I change strategies when I fail to understand.	0.63
I re-evaluate my assumptions when I get confused.	0.69
I stop and go back over new information that is not clear.	0.66
I know how well I did once I finish a test.	0.59
I ask myself if there was an easier way to do things after I finish a task.	0.66
I summarize what I've learned after I finish.	0.51
I ask myself how well I accomplish my goals once I'm finished.	0.65
I ask myself if I have considered all options after I solve a problem.	0.71
I ask myself if I learned as much as I could have once I finish a task.	0.56

Table 10. Item Loadings for Knowledge about Cognition (MA-K) Scale

Item	*Loading*
I understand my intellectual strengths and weaknesses.	0.47
I know what the teacher expects me to learn.	0.43
I am good at remembering information.	0.62
I have control over how well I learn.	0.47
I am a good judge of how well I understand something.	0.59
I learn more when I am interested in the topic.	0.44
I try to use strategies that have worked in the past.	0.53
I find myself using helpful learning strategies automatically.	0.67
I learn best when I know something about the topic.	0.51
I know when each strategy I use will be most effective.	0.64

Table 11. Item Loadings for Intrinsic Motivation (IM) Scale

Item	*Loading*
I enjoyed the projects in this course very much.	0.76
The projects in this course were fun to do.	0.72
I thought the projects in this course were boring.	-0.48
The projects in this course did not hold my attention at all.	-0.47
I would describe the projects in this course as very interesting.	0.66
I thought the projects in this course were quite enjoyable.	0.69
I think I am pretty good at the projects in this course.	0.71
After working at the projects in this course for awhile, I felt pretty competent.	0.73
I am satisfied with my performance at the projects in this course.	0.65
I was pretty skilled at the projects in this course.	0.62
I couldn't do the projects in this course very well.	-0.52
I believe the projects in this course could be of some value to me.	0.69
I think that doing the projects in this course is useful for me.	0.68
I think that doing the projects in this course is useful for my career.	0.62
I think the activities in this course are important to do because they can help me in my career.	0.65
I would be willing to do the projects in this course again because they have some value to me.	0.69
I think doing the projects in this course could help me to get a job/internship.	0.74
I believe doing the projects in this course could be beneficial to me.	0.68
I think the projects in this course are important.	0.59