Validation of the Instructional Materials Motivation Survey: Measuring Student Motivation to Learn via Mixed Reality Nursing Education Simulation

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Abstract: Motivation to learn is an important component of education, particularly in the field of educational technology in which the instructor's physical presence is increasingly absent. The complexity of the many factors that contribute to student motivation renders this domain difficult to measure. The Instructional Materials Motivation Survey (IMMS) instrument was created to measure and identify issues related to student motivation within the use of self-directed learning materials. The IMMS was designed to measure the degree to which the learner becomes engaged in the learning experience through elements of attention, relevance, confidence, and satisfaction (ARCS). Since its creation, several academic studies have made use of the IMMS to assess student motivation, however these studies demonstrate a lack of consensus on the validity and reliability of the instrument. This study examined the validity and reliability of the IMMS as measured by baccalaureate nursing students who completed the IMMS survey instrument following a clinical training simulation. Validation of the survey data retained 19 IMMS items distributed across all four ARCS subscales. The findings reported extend previous validation evidence by validating the instrument with mixed reality instructional simulation. These findings demonstrate the agnostic nature of the IMMS instrument with regard to instructional delivery medium.

Introduction

Motivation to learn is an important component of education, however the complexity of the many factors that contribute to student motivation renders this domain difficult to measure. The importance, coupled with complexity, is particularly true in the field of educational technology, where the instructor's physical presence is increasingly absent. This can challenge attention to the most basic motivational supports such as formative encouragement and feedback. The importance of student motivation in educational technology, combined with the growing prevalence of emergent teaching and learning approaches that include flipped classrooms, online learning, and immersive simulations, makes motivation to learn an important, and urgently contemporary, topic.

Background

In the book, *Motivation, Learning, and Technology*, Spector and Park (2018) elaborate a comprehensive outline of student motivation to learn within the context of educational technology. The outline includes motivational conceptual and theoretical frameworks, as well as examples of applied educational technology techniques for promoting student motivation. Additionally, the authors cite research in support of these concepts, theories, and techniques. One of the frameworks cited by Spector and Park is John Keller's ARCS model (Keller 1987; Keller 1999; Keller 2010). The ARCS model asserts that motivation to learn is comprised of the degree to which the learner becomes engaged in the learning experience through elements of attention, relevance, confidence, and satisfaction, as shown in Figure 1.

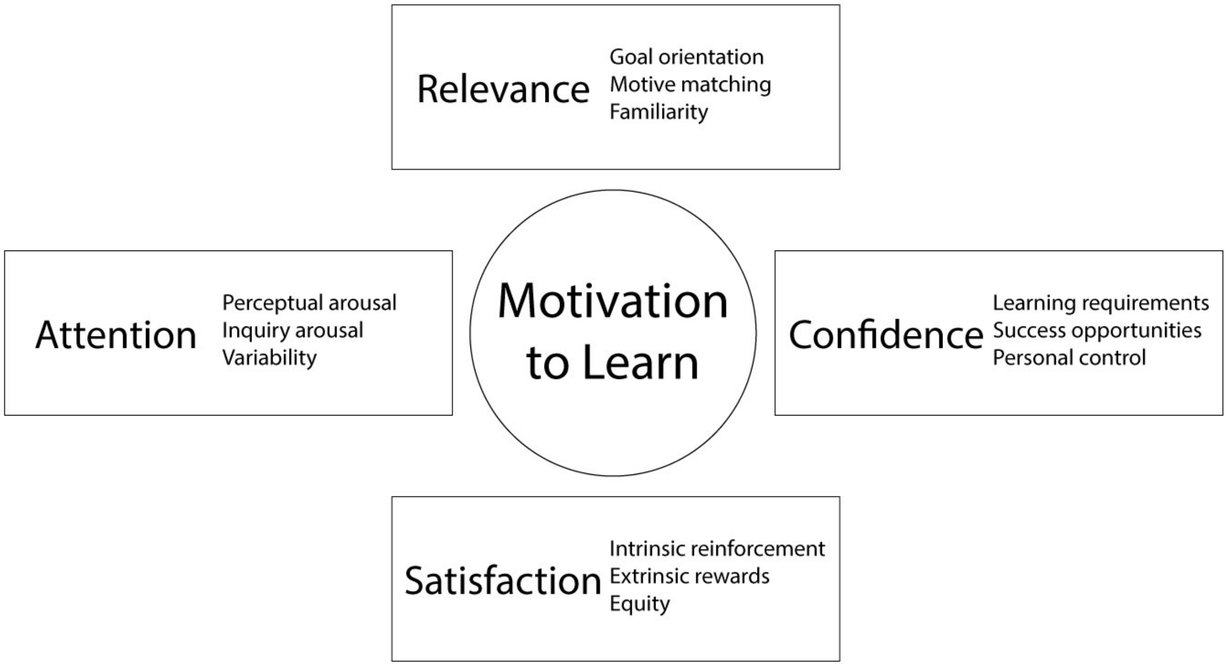

Figure 1: The ARCS Model (Keller, 1987).

Underpinnings of ARCS Model

Keller's ARCS model was heavily influenced by "Expectancies, Values, and Academic Behaviors," in which Eccles et al. (1983) propose the expectancy–value model of achievement performance and choice. In this model, *expectancies* are defined as the degree to which a learner expects to succeed, and *values* as the subjective benefit a learner perceives—both of which are shown to influence achievement. The researchers suggest educational achievement is directly related to the ability of the student, the confidence of the student, and the effort that the student applies. The effort component is influenced by the degree to which the student finds the content useful, important, and interesting. This theory suggests students must not only possess the ability to master the content but must also feel confident in their ability to do so. Additionally, they must see value in the content, and therefore be motivated to apply themselves to the content.

Keller (1979) outlined the importance of considering student motivation to learn in the educational technology design process in the article titled "Motivation and Instructional Design: A Theoretical Perspective." Here, Keller highlighted the lack of attention paid to the motivation of the individual learner, while emphasizing theoretical underpinnings that point to the importance of student motivation. Keller defined student performance as the confluence of inherent student ability and the degree to which the educational technology materials are well designed and managed. The factors inherent to the student are individual abilities, skills, and knowledge, over which the instructional designer has no control. The learning design and management, however, is within the control of the instructional designer, and thus of great importance.

Another component of motivation is outlined in the article, "A Theory of Human Motivation," in which Maslow (1943) outlines a theory of motivation, defined by a hierarchy of basic needs. These basic needs consist of physiology, safety, love, esteem, and self-actualization, with each step in the hierarchy being necessary in order to meet the next. Maslow links this hierarchy with a propensity for basic human goals, thus if basic needs are not met, more advanced goals cannot be pursued.

The level within the hierarchy of relevance to this study is that of esteem, which encompasses self-confidence. Maslow posits depravation of esteem needs, including confidence, can lead to feelings of weakness, inferiority, and helplessness. This creates a scenario where the learner is unable to focus on self-actualization due to the deprivation of esteem. Conversely, when esteem needs are met the learner experiences feelings of competence, mastery, and empowerment.

Measuring Student Motivation: The Instructional Materials Motivation Survey

To measure the four constructs of the ARCS model, Keller (1993) developed the Instructional Materials Motivation Survey (IMMS). This instrument was created to measure and identify issues related to student motivation within the use of self-directed learning materials, thus the IMMS was employed to measure nursing student motivational attitudes toward the use a self-directed anaphylaxis case study scenario. The 36 Likert-scale questions of the survey prompt users to rate their response to each statement such that 1 = *strongly disagree with the statement,* 2 = *disagree with the statement*, 3 = *neither agree or disagree with the statement*, 4 = *agree with the statement*, and 5 = *strongly agree with the statement*. The 36 questions represent four constructs matching that of the ARCS model, including *attention* (12 questions), *relevance* (9 questions), *confidence* (9 questions), and *satisfaction* (6 questions). These constructs are shown in Table 1.

Table 1: Constructs of the Instructional Materials Motivation Survey.

Construct	**Definition**
IMMS Attention	IMMS survey responses measuring the degree to which the learner found the scenario attention-grabbing.
IMMS Relevance	IMMS survey responses measuring the degree to which the learner found the scenario relevant.
IMMS Confidence	IMMS survey responses measuring the degree to which the learner felt confident while completing the scenario.
IMMS Satisfaction	IMMS survey responses measuring the degree to which the learner found the scenario satisfying.

Historical Studies that Validated the IMMS

Since its creation, several academic studies have made use of the IMMS to assess student motivation with the goal of improving the effectiveness of learning activities. We highlight findings from these two studies as antecedents to the current validation effort (Huang, Huang, Diefes-Dux, & Imbrie, 2006; Loorbach, Peters, Karreman, & Steehouder, 2015).

A preliminary validation the IMMS instrument was completed by Huang, Huang, Diefes-Dux, and Imbrie (2006). This study investigated the use of IMMS to measure motivation with the use of a computer-based tool called M-Tutor to support engineering education among first year undergraduate engineering students (n=875). Through factor analysis, the authors determined that 20 of the 36 IMMS questions fit within the four constructs of the ARCS model; therefore, data from the remaining 16 questions were omitted during analysis of the results.

In order to perform this validation, the researchers used exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to determine which of the IMMS questions fit within the theoretical constructs defined in the ARCS model. The authors first used Statistical Package for the Social Sciences (SPSS) to test the dimensionality of the 36 IMMS questions via EFA, from which authors chose items with a factor loading above .60 and with little or no cross loading. Next, the authors used LISREL to perform a CFA in order to identify if the remaining items fit within the theoretical constructs of ARCS. The authors then used Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), root mean square error of approximation (RMSEA), and Normed Fit Index (NFI) to determine the degree to which the IMMS questions fit within the model. The researchers used GFI, AGFI and NFI values closer to1 as a better model fit, and RMSEA values less than .05.

Although only 20 of the 36 IMMS items fit within the construct as measured by the parameters outlined above, the authors suggested future research should be performed to further validate the IMMS instrument. This call, in part, fueled the current validation effort.

Another study measuring the validity of the IMMS instrument resulted in a reduced Instructional Materials Motivation Survey, referred to by the authors as *RIMMS* (Loorbach, Peters, Karreman, & Steehouder, 2015). This study examined the results of Dutch senior citizens (n=138) between the ages of 60 and 70 years who completed the IMMS after following self-directed cell phone usage instructions. Through confirmatory factor analysis, the research team determined that a subset of 12, of the original 36 IMMS questions, were the best fit for the ARCS model and its four components of attention, relevance, confidence, and satisfaction, in the researchers' context. Thus, the team named the abridged version of IMMS the Reduced Instructional Materials Motivation Survey (RIMMS).

Aim of this Study

The highlighted studies demonstrate a lack of consensus on the validity and reliability of the IMMS. Additionally, the validation research lacks investigation related to use of IMMS to measure student motivation to learn through simulations, in particular. This study examined the reliability of the IMMS as measured by baccalaureate nursing students (n=161) who completed the IMMS survey instrument following a clinical training simulation.

Methodology

This study utilized data collected from baccalaureate nursing students enrolled at two campuses within the California State University system who participated in a low-frequency, high-risk anaphylaxis scenario case study. The research was approved by the authors' institutional review board as an initial step. Then, data was collected through a collaboration between San Diego State University's Instructional Technology Services and School of Nursing.

Participants included baccalaureate nursing students (n=161) enrolled in four levels of nursing courses, shown in Table 2. The four levels are defined as level 1 (n=65), which consisted of students familiar with reading case studies with no formal clinical experience; level 2 (n=60), which consisted of students with basic clinical experience; level 3 (n=14), which consisted of students with extensive clinical experience; and level 4 (n=22), which consisted of registered nurse (RN) students with professional clinical nursing experience.

Table 2: Nursing Levels.

Nursing Level	N	Description
Level 1	65	Nursing fundamentals students familiar with reading case studies but no formal clinical experience
Level 2	60	Medical-surgical nursing students with basic clinical experience
Level 3	14	Advanced medical-surgical nursing students with extensive clinical experience
Level 4	22	Licensed registered nurse (RN) students with professional clinical nursing experience who returned to nursing school to obtain a Bachelor of Science (BS) in nursing

Participating students from the four levels of nursing courses were stratified and randomly assigned to one of the following groups: Research group 1, which provided students with an anaphylaxis simulation via traditional two-dimensional video plus a written case study (n=54); research group 2, which provided students with a three-dimensional, mixed reality anaphylaxis simulation via the Microsoft HoloLens plus a written case study (n=53); and the control group, which provided students with an anaphylaxis written case study containing two-dimensional still images (n=54).

Data Collection and Analysis

All participants received written instructions accompanied by a case study. Each student completed a pre-survey to document previous clinical and simulation experience. Upon finishing each anaphylaxis observation, participants completed a knowledge measure to determine understanding of the content conveyed in the corresponding observation. After finishing all three anaphylaxis observations and knowledge measures, each participant completed

35 IMMS questions shown in Appendix A. The question that was removed from the original 36-question IMMS was "After working on the simulation for a while, I was confident that I would be able to pass a test on anaphylaxis." Because this question contained reference to the specific topic of the instruction—in this case, anaphylaxis—the question was removed to avoid inadvertently interfering with the knowledge measure component of the study by providing students with the diagnosis of the patient. Minor modifications were also made to the wording of questions to accommodate the modality of simulation as the instructional technology being studied. Reverse items, built into several of the Likert-scale questions to account for response bias or fatigue, were reverse-coded in the SPSS dataset.

Exploratory factor analysis (EFA) was performed on the resulting 35 IMMS variables to assess the ability of the survey instrument to measure the latent ARCS constructs of motivation. The EFA was performed using the Statistical Package for the Social Sciences (SPSS) with the principle components method of extraction, followed by an orthogonal varimax rotation (Kaiser, 1958). Items with factor loading above .50 and with little to no cross loading (<0.30) were retained. Following the EFA, confirmatory factor analysis (CFA) was administered using the SPSS Analysis of a Moment Structures (AMOS) module to measure the convergent and discriminant validity of the items retained in the EFA and their constructs (Cole, 1987).

Results

The EFA and CFA validation effort retained 19 IMMS items fit within the original four constructs of the scale. This reduced, validated version of the IMMS scale included eight items within the *attention* construct, four questions within the *relevance* construct, four questions within the *confidence* construct, and three questions within the *satisfaction* construct. The 19 validated IMMS items shared some items from those of the Huang, Huang, Diefes-Dux, and Imbrie (2006) and Loorbach, Peters, Karreman, and Steehouder (2015) studies, however differences exist.

The 19 variables retained in the EFA formed four factors with eigenvalues greater than 1, which collectively explained 61.6% of the variance. The Kaiser-Meyer-Olkin measure verified the sampling adequacy of the analysis, with a .88 value well above the acceptable limit of .50 (Hutcheson & Sofroniou, 1999). Table 3 presents the factor loadings after rotation, forming four factors representing the underlying ARCS constructs: Attention, relevance, confidence, and satisfaction.

Table 3: Exploratory Factor Analysis of IMMS: Rotated Component Matrix.

Item	Rotated Factor Loadings			
	A	**R**	**C**	**S**
There was something interesting at the beginning of this simulation that caught my attention. (IMMS_ATTN1)	.70	—	—	—
These materials are eye catching. (IMMS_ATTN2)	.71	—	—	—
The quality of the simulation helped to hold my attention. (IMMS_ATTN3)	.75	—	—	—
The content of this simulation looks dry and unappealing. (IMMS_ATTN5R)	.70	—	—	—
The way the information is arranged in the simulation helped keep my attention. (IMMS_ATTN6)	.68	—	—	—
The amount of repetition in this simulation caused me to get bored sometimes. (IMMS_ATTN8R)	.80	—	—	—
The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the lesson. (IMMS_ATTN10)	.73	—	—	—

Item	Rotated Factor Loadings			
	A	R	C	S
This simulation is boring. (IMMS_ATTN11R)	.63	—	—	—
Completing this simulation successfully was important to me. (IMMS_REL3)	—	.72	—	—
The content of this simulation is relevant to my interests. (IMMS_REL4)	—	.63	—	—
The content in this simulation conveyed the impression that the content is worth knowing. (IMMS_REL6)	—	.57	—	—
I could relate to the content of this simulation to things I have seen, done or thought about in my own life. (IMMS_REL8)	—	.51	—	—
This material was more difficult to understand than I would like for it to be. (IMMS_CON2R)	—	—	.80	—
Many of the pages had so much information that it was hard to pick out and remember the important points. (IMMS_CON4R)	—	—	.67	—
The exercises in this simulation were too difficult. (IMMS_CON6R)	—	—	.75	—
I could not really understand quite a bit of the material in this simulation. (IMMS_CON8R)	—	—	.80	—
Completing the exercises in this simulation gave me a satisfying feeling of accomplishment. (IMMS_SAT1)	—	—	—	.61
The wording of feedback after the exercises, or of other comments in this lesson, helped me feel rewarded for my effort. (IMMS_SAT4)	—	—	—	.71
It felt good to successfully complete this simulation. (IMMS_SAT5)	—	—	—	.55
Eigenvalues	7.37	1.28	1.94	1.12
% of variance	38.8%	6.7%	10.2%	5.9 %
α	.93	.60	.79	.71

The results of the CFA indicated acceptable factor loading estimates (convergent validity) and correlation values (discriminate validity) for all 19 items present in the latent variables. The resulting structural equation model (SEM) is presented in Figure 1. Additionally, Table 4 outlines the model fit measures in which the chi-square model fit statistic ($\chi^2 = 243.53$, $df = 146$), comparative fit index (CFI = .93), normed fit index (NFI = .84), and root mean square error of approximation (RMSEA = .06, $p > .05$) all indicate an acceptable model fit (Browne & Cudeck, 1993).

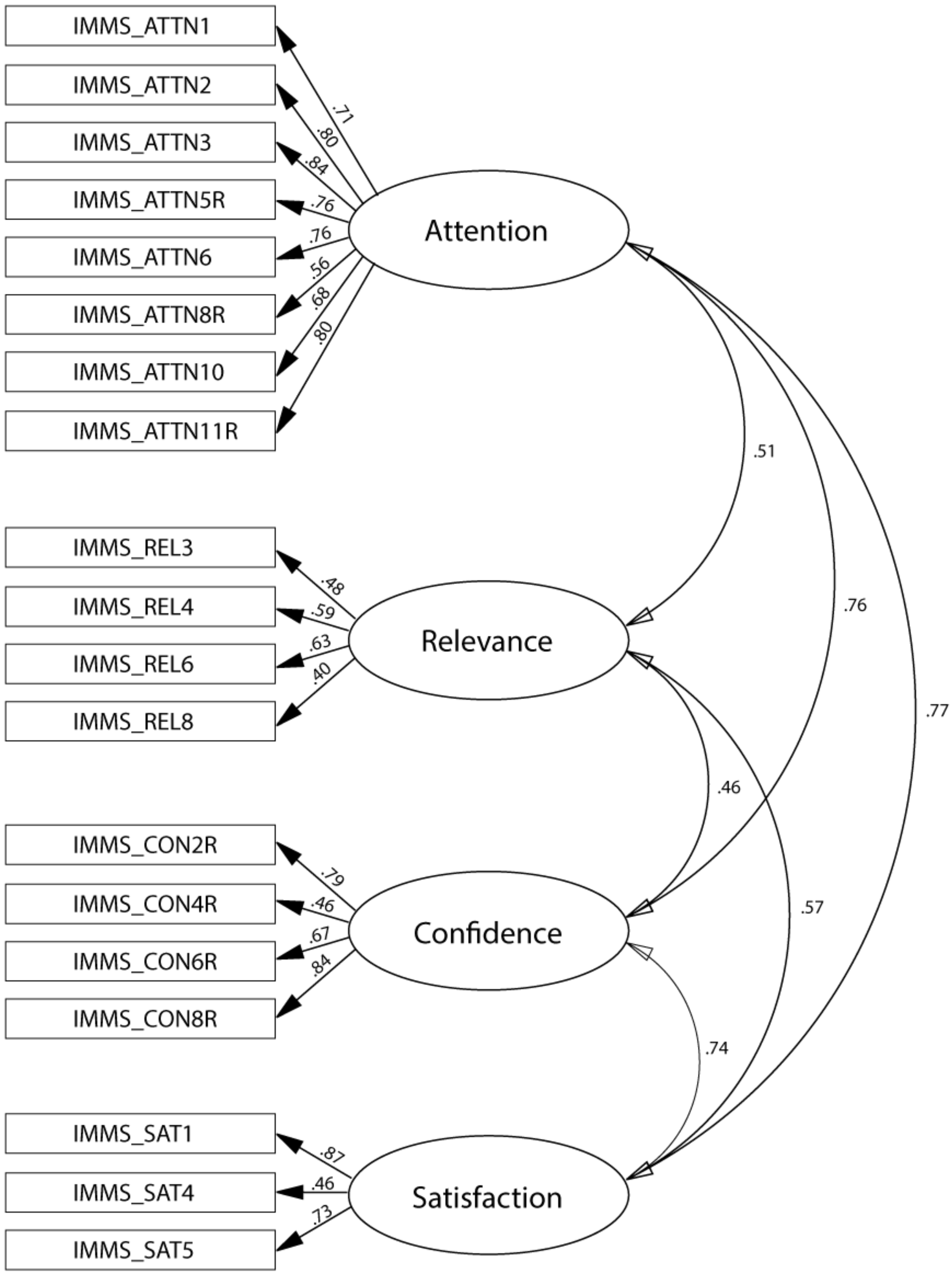

Figure 1: Confirmatory Factor Analysis (CFA) Structural Equation Model (SEM).

Table 4: Confirmatory Factor Analysis Model Fit Indices.

Model Fit Measure	**Value**
Chi-square model fit statistic/degrees of freedom (X^2/df)	243.53/146
Akaike information criterion (AIC)	369.52
Comparative fit index (CFI)	.93
Normed fit index (NFI)	.84
Root mean square error of approximation (RMSEA)	.06

Reliability analysis of the 19 retained IMMS items showed Cronbach's α internal consistencies of .93 for the eight items measuring *attention*, .60 for the four questions measuring *relevance*, .79 for the four questions related to *confidence*, and .71 for the three questions measuring *satisfaction*. While the initial Cronbach's α values for each of the four IMMS constructs was considered acceptable, analysis of each question was performed to determine if the Cronbach's α values for each of the four scales could be improved by removing individual questions (Nunnally & Bernstein, 1967). Table 5 shows the Cronbach's Alpha values for the eight questions measuring *attention.* The initial Cronbach's Alpha of .93 was higher than any value if item deleted, therefore no questions measuring *attention* were removed.

Table 5: Cronbach's α Values for the Eight Items Measuring Attention (α=.93).

Attention Questions	**Cronbach's α if Item Deleted**
There was something interesting at the beginning of this simulation that caught my attention. (IMMS_ATTN1)	.89
These materials are eye catching. (IMMS_ATTN2)	.89
The quality of the simulation helped to hold my attention. (IMMS_ATTN3)	.88
The content of this simulation looks dry and unappealing. (IMMS_ATTN5R)	.89
The way the information is arranged in the simulation helped keep my attention. (IMMS_ATTN6)	.89
The amount of repetition in this simulation caused me to get bored sometimes. (IMMS_ATTN8R)	.91
The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the lesson. (IMMS_ATTN10)	.90
This simulation is boring. (IMMS_ATTN11R)	.88

Table 6 provides the Cronbach's α values for the four questions measuring *relevance.* The initial Cronbach's α of .60 was the same or higher than any value if item deleted, therefore no questions measuring *relevance* were removed.

Table 6: Cronbach's α Values for the Four Items Measuring Relevance (α=.60).

Relevance Questions	**Cronbach's α if Item Deleted**
Completing this simulation successfully was important to me. (IMMS_REL3)	.52
The content of this simulation is relevant to my interests. (IMMS_REL4)	.48
The content in this simulation conveyed the impression that the content is worth knowing. (IMMS_REL6)	.52

Relevance Questions	Cronbach's α if Item Deleted
I could relate to the content of this simulation to things I have seen, done or thought about in my own life. (IMMS_REL8)	.60

Table 7 shows the Cronbach's α values for the four questions measuring *confidence.* The initial Cronbach's α of .79 was the same or higher than any value if item deleted, therefore no questions measuring *relevance* were removed.

Table 7: Cronbach's α Values for the Four Items Measuring Confidence (α=.79).

Confidence Questions	Cronbach's α if Item Deleted
This material was more difficult to understand than I would like for it to be. (IMMS_CON2R)	.69
Many of the pages had so much information that it was hard to pick out and remember the important points. (IMMS_CON4R)	.79
The exercises in this simulation were too difficult. (IMMS_CON6R)	.75
I could not really understand quite a bit of the material in this simulation. (IMMS_CON8R)	.69

Table 8 highlights the Cronbach's α values for the three questions measuring *satisfaction.* Removing any individual question measuring *satisfaction* does not result in a substantially higher Cronbach's α that the initial .71, therefore no questions measuring *satisfaction* were removed.

Table 8: Cronbach's α Values for the Three Items Measuring Satisfaction (α=.71).

Satisfaction Questions	Cronbach's α if Item Deleted
Completing the exercises in this simulation gave me a satisfying feeling of accomplishment. (IMMS_SAT1)	.50
The wording of feedback after the exercises, or of other comments in this lesson, helped me feel rewarded for my effort. (IMMS_SAT4)	.76
It felt good to successfully complete this simulation. (IMMS_SAT5)	.58

Discussion and Implications

The results indicate that the Cronbach's α for all 19 retained items within the IMMS instrument, minimally adapted for use in a simulation-focused study, were within an acceptable range for internal consistency. These findings, compared with previous similar studies, show the IMMS items fit within the designed constructs to the same degree or better as previously shown. A possible reason for this good fit is due to the nature of this study being carried out in a traditional higher education environment, for which the ARCS model and IMMS instrument were originally designed. The study carried out by Huang, Huang, Diefes-Dux, and Imbrie (2007) also involved undergraduate university participants, which resulted in the same number of items removed. In contrast, the Loorbach, Peters, Karreman, and Steehouder study (2015)—which employed IMMS to measure motivation among senior citizen participants in a non-traditional learning environment—removed 24 of the original 36 items.

Distribution of Retained Items

The 19 IMMS items retained are distributed across all four ARCS subscales, with at least three items in each construct. This does provide a more even representation across the four constructs than the aforementioned Huang, Huang, Diefes-Dux, and Imbrie (2007) study, in which only one of the 20 items (5%) retained belonged to the *satisfaction* domain. Additionally, the proportion of the items retained in this study within each construct is roughly proportional to the number of items present in the pre-validated IMMS scale: Eight of 12 *attention* items (66.6%), four of nine *confidence* items (44.4%), four of nine *relevance* items (44.4%), and three of six *satisfaction* items (50%) were retained. Additionally, the retention of seven of the original 10 reverse-coded questions (appended with "R" in the tables and figures) demonstrates the resilience of the IMMS scale to respondent bias and fatigue.

Strength of Fit

The ARCS model attends to four unique constructs that, together, support the design of motivating instruction. Developed decades ago and long before today's advanced technologies, the four domains have largely remained agnostic with regard to the means of instruction delivery.

Results from this effort's exploratory and confirmatory factor analyses mirror previous validation efforts of the involved instrument and resulting ARCS-specific scales. This includes the original effort to produce the IMMS by Huang, Huang, Diefes-Dux, and Imbrie (2006). The work of these researchers crafted the preliminary version of the IMMS instrument by fielding 36 items. Factor analysis resulted in a final set of 20 questions. Similar to this effort, these authors used EFA and CFA to determine the fit between the resulting scales and the four constructs of the ARCS model. These procedures were followed by additional investigation to quantify the fit between the final question bank and overall model.

Our replication effort has followed the same factor analysis procedures, as described in our findings. The four ARCS model constructs remain present and pronounced in the current dataset. This finding provides yet another instance of the ARCS model universality. The present effort sought to apply the model, and related assessment, to a simulation-based learning experience. This treatment was a new application for the instrument. Yet, regardless of the instruction delivery and related, albeit minor, modifications to the questions, each of the preserved IMMS items loaded to the corresponding construct.

Taken together, these findings may assert two conclusions. The first, as we have discussed, is the ARCS model's agnostic nature with regard to delivery medium. This has been an historical tenet of the model, with increasing evidence that it holds constant even when faced with advanced and increasingly complex delivery technologies. Second, the replication of the previous study, including results from the EFA, CFA, and scale validation, provide additional assurance of the instrument's efficacy in measuring motivation derived from instruction.

Context First

It is important to note that this effort was initiated as a result of context. The authors sought to use the previously validated IMMS instrument in a new, and novel, instructional setting. With roots in instructional systems design, the ARCS model has long been applied to the design of workforce training (for example, Marshall & Wilson, 2013). It has increasingly been applied in higher education, likely hastened by the emergence of instructional designer support for faculty, and often in the context of online course development (Kumar & Ritzhaupt, 2017). The previous validation efforts confirm this typification, and demonstrate the contemporary interest from institutions of higher education.

Our interest was fueled by the application of ARCS to simulation, and simulation via mixed reality. Our validation results add to the existing body of evidence supporting the use of the IMMS as a valid, reliable measure of the ARCS constructs. Yet, within this discussion, it is important to state that context remains a critical consideration. The findings reported here extend previous validation evidence by validating the instrument with mixed reality instruction. Potential adopters of the IMMS are advised to carefully consider the context of their instructional experience, and its alignment with this, and previous, validation studies. As with the study reported herein, the application of the instrument to a new instructional context likely call for further validation efforts. Our findings, coupled with previous efforts, have provided evidence that points to the ARCS model, and corresponding instrument's, agnostic nature, with regard to delivery medium and instructional content.

Limitations

The limitations of this validation effort must be acknowledged. This validation effort was conducted with specialized content and a novel delivery method. The involved instruction was provided to students studying nursing at the undergraduate level. It was delivered through the mixed reality Microsoft HoloLens device. Generalizability of the IMMS validation findings to non-nursing content, as well as other simulation, or alternate delivery technologies, is unknown.

References

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. *SAGE Focus Editions, 154,* 136-136.

Cole, D. A. (1987). Utility of confirmatory factor analysis in test validation research. *Journal of Consulting and Clinical Psychology, 55*(4), 584.

Eccles J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M.,Meece, J. L., &Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 75–146). San Francisco, CA: W. H. Freeman.

Huang, W., Huang, W., Diefes-Dux, H., & Imbrie, P. K. (2006). A preliminary validation of Attention, Relevance, Confidence and Satisfaction model-based Instructional Material Motivational Survey in a computer-based tutorial setting. *British Journal of Educational Technology, 37*(2), 243-259.

Hutcheson, G. D., & Sofroniou, N. (1999). The multivariate social scientist: Introductory statistics using generalized linear models. London: SAGE Publications Ltd.

Kaiser, H. F. (1958). The varimax criterion for analytic rotation in factor analysis. *Psychometrika, 23*(3), 187-200.

Keller, J. M. (1979). Motivation and instructional design: A theoretical perspective. *Journal of Instructional Development, 2*(4), 26.

Keller, J. M. (1987). Development and use of the ARCS model of instructional design. *Journal of Instructional Development, 10*(3), 2.

Keller, J. M. (1993). *Manual for instructional materials motivational survey (IMMS).* Unpublished manuscript, Tallahassee, FL.

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

Keller, J. M. (2009). *Motivational design for learning and performance: The ARCS model approach.* Berlin: Springer Science & Business Media.

Kumar, S. & Ritzhaupt, A. (2017). What do instructional designers in higher education really do? *International Journal on E-Learning. 16*(4), pp. 371-393.

Loorbach, N., Peters, O., Karreman, J., & Steehouder, M. (2015). Validation of the Instructional Materials Motivation Survey (IMMS) in a self-directed instructional setting aimed at working with technology. *British Journal of Educational Technology, 46*(1), 204-218.

Marshall, J., & Wilson, M. (2013). Motivating e-learners: Application of the ARCS model to e-learning for San Diego Zoo Global animal care professionals. *Journal of Applied Instructional Design, 3*(12): 21-30.

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review, 50*(4), 370.

Nunnally, J. C., & Bernstein, I. H. (1967). *Psychometric theory (Vol. 226).* New York: McGraw-Hill.

Spector, J. M., & Park, S. W. (2018). *Motivation, learning, and technology: Embodied educational motivation.* New York; London: Routledge.