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A cross-cultural adaptation and validation of the Icelandic version of the MUSIC Model of Academic Motivation Inventory

We describe the cross-cultural adaptation of the middle and high school version of the MUSIC® Model of Academic Motivation Inventory (Jones, 2012) into Icelandic, in order to provide Icelandic educators with a tool to assess motivation and guide the selection of teaching strategies. The inventory measures students´ perceptions of the five components of the MUSIC® Model of Motivation (Jones, 2009, 2015): e**M**powerment, **U**sefulness, **S**uccess, **I**nterest, and **C**aring. Back-translation of the MUSIC Inventory, followed by expert meetings, was used to gain semantic equivalence. Participants were 458 Icelandic students in fifth to eighth grade. To obtain translation equivalence, we used an exploratory factor analysis that involved principal axis factoring with promax rotation. Subsequently, we implemented a confirmatory factor analysis with a different sample of students to test for model fit. The results replicated the findings obtained with the original version and confirmed the five-factor structure, providing validity evidence for the scores produced by using the Icelandic version.

Keywords: academic motivation, instrument translation, adaptation, validation, engagement, MUSIC Model of Motivation

INTRODUCTION

It is important for teachers to consider student motivation because it is strongly related to learning and achievement (Schunk, Meece, & Pintrich, 2014). For example, motivated students tend to engage in their studies, persist when faced with challenges, and learn and achieve more than unmotivated students (Ames, 1992; Stipek, 1993). However, motivating students in the classroom is a complex issue, involving cognitive, affective, and contextual factors. Because of this complexity, it can be difficult for teachers to assess and, subsequently, influence students' motivation. To complicate matters further, the abundant use of jargon in motivation research and myriad motivational concepts make it difficult for teachers to know which motivation concepts to assess and address when planning instruction.

The MUSIC® Model of Academic Motivation Inventory (MUSIC Inventory) (Jones, 2012) has been shown to be a useful tool to help educators, researchers, and instructional designers measure students' motivation (e.g., Jones, 2015; Jones & Sigmon, 2016; Jones & Skaggs, 2016; Parkes, Jones, & Wilkins, 2015). The inventory is based on the MUSIC® Model of Motivation (MUSIC model) (Jones, 2009, 2015), developed after a thorough analysis of motivation theories and research. Because the MUSIC model and the associated MUSIC Inventory have been successfully used with samples of students in the United States of America (US), we hypothesized that an Icelandic version of the MUSIC Inventory might also work well with students in Iceland. The purpose of our study was to examine the validity evidence for the MUSIC Inventory when translated into Icelandic and used with Icelandic middle school students in science classes. If the inventory was shown to produce valid scores with this sample of students, it could be a useful tool for teachers interested in redesigning their instruction to improve the motivation of their students.

A conceptual framework: The MUSIC® Model of Motivation

The MUSIC model includes current conceptions of motivation, shown to be critical to students' motivation and engagement (Jones, 2009, 2015). According to the research on which the model builds, motivation increases when students: perceive that they have some control over their learning (i.e., *eMpowerment*), understand the *Usefulness* or value in their learning, believe that they can be *Successful*, are *Interested* or enjoy the learning activities, and feel *Cared* for in the classroom environment (MUSIC is an acronym for these five motivation components). Jones' purpose in developing the MUSIC model was to assist instructors in understanding the complex results of recent motivation research and to provide them with tools for implementing these motivation factors by intentionally choosing teaching strategies that are likely to motivate students (Jones, 2009).

Jones (2012) developed the MUSIC Inventory, which has been validated in several contexts, including use with college students (Jones & Skaggs, 2016), middle and high school students (Jones & Wilkins, 2013b, 2015; Parkes et al., 2015), and elementary students (Jones & Sigmon, 2016). On the inventory, students are asked to rate their perception of the presence of the five MUSIC components (i.e., empowerment, usefulness, success, interest, and caring) in the classroom context. Because each MUSIC Inventory subscale corresponds to one of these five MUSIC components, instructors can utilize the scores to inform their instruction. For example, if students rate a teacher lower on the interest component, then that teacher can consider strategies specifically designed to increase students' interest. At the middle school level, the MUSIC Inventory has been used in a variety of subject areas, including science (Jones & Wilkins, 2013b, 2015) and music and band ensemble classes (Parkes et al., 2015). The definitions for each of the MUSIC Inventory subscales is provided in Table 1 and in the remainder of this section, we explain each MUSIC model component in more detail.

Table 1. The MUSIC constructs and their definitions

MUSIC model constructs	Definitions The degree to which a student perceives that:	Related constructs
Empowerment	he or she has control of his or her learning environment in the course	Autonomy (Deci & Ryan, 1991)
Usefulness	the coursework is useful to his or her future	Utility value (Wigfield & Eccles, 2000)
Success	he or she can succeed at the course-work	Expectancy for success (Wigfield & Eccles, 2000)
Interest	the instructional methods and course-work are interesting	Situational interest (Hidi & Renninger, 2006)
Caring	the instructor cares about whether the student succeeds in the course-work and cares about the student's well-being	Caring (Noddings, 1992)

Note. This table was used with permission from Jones (2016)

Empowerment. In the MUSIC model, empowerment refers to the amount of control that students believe that they have over their learning. Control, or autonomy, has been shown to be an important factor in student motivation (Deci & Ryan, 2000, 2002). One way to increase students' perceptions of control is to give them some choices within a task structure. When students feel in control, they believe they can influence events and outcomes, and they experience an ownership of the results of their work, which can lead to increased motivation and encourage self-regulation. Students who are in control can also learn to organize themselves, make decisions, and meet deadlines. Students perceive increased control when they feel that their opinions matter (Logan & Skamp, 2008). An instructional context that includes autonomy and choices has been shown to positively influence motivation (Deci & Ryan, 1985; Hidi & Harackiewicz, 2000), engagement, and achievement (de Charms & Shea, 1976; Deci & Ryan, 2000; McCombs, 1994).

Usefulness. The concept of usefulness in the MUSIC model refers to students' perceptions of how a learning activity can be useful to them, presently or in the future (Jones, 2009). Believing that an activity is useful can increase students' motivation and engagement (Wigfield & Eccles, 2000), especially if the effort is perceived to be beneficial for long-term goals (Simons, Vansteenkiste, Lens, & Lacante, 2004). The usefulness construct is related to the utility value that students place on tasks, as described in expectancy-value theory (Wigfield & Eccles, 2000).

Success. The success component of the MUSIC model refers to the extent to which students believe that they can succeed if they put forth effort. Deci and Ryan (2000) suggested that individuals are motivated by a need to grow and be fulfilled. Their natural

actions aim at mastering challenges and new experiences to gain a positive sense of self. This feeling of competence or being good at what one does is an important need and a key to psychological growth (Deci & Ryan, 2000; Elliot & Dweck, 2005). For students, it is vital to know that they have the possibility of succeeding in their work if they put forth the effort. They are not likely to make an effort if they perceive the goal as unattainable. Personal expectations predict performance, the choice of courses in school, and occupational choices (Bandura, 1997). When individuals perceive that they can be successful (i.e., they have self-efficacy for the task), they are more likely to be motivated to perform the task (Bandura, 1997; Björnsdóttir, Kristjánsson, & Hansen, 2008).

Interest. For the MUSIC Inventory, interest is defined as the immediate, short-term enjoyment of and interest in instructional activities. Interest is related to many positive outcomes, including attention, memory, comprehension, deeper cognitive engagement, thinking, goal setting, learning strategies, and achievement (Hidi & Renninger, 2006; Schunk et al., 2014). Those who are interested in a subject or an activity will be engaged and show motivated behaviors, such as choosing or focusing on the task, showing effort, endurance, and accomplishment. Thus, interest is an important motivational variable (Hidi & Harackiewicz, 2000; Jones, 2009; Tobias, 1994) and it can be stimulated through social interaction, suspense, controversy, games, novelty, humor, or situations that engender emotions (Bergin, 1999).

Caring. The caring component of the MUSIC model involves the extent to which students feel the instructor and other students care about whether they succeed in class and school, and care about their well-being (Jones, 2009). A caring classroom environment promotes motivation, learning, and general well-being (Bandura, 1997), in part, because humans have a need for caring and meaningful relationships (Baumeister & Leary, 1995; Deci & Ryan, 1985, 2000; Hagerty, Lynch-Sauer, Patusky, & Bouwsema, 1993). Hagerty et al. (1993) proposed that genuine caring probably only develops when people get to know each other, that is, when they establish relatedness. Similarly, Deci and Ryan (1985) describe relatedness as people's need to experience a feeling of belonging, or an attachment to an individual or a group. Research has shown that students who perceive that their teacher cares for them are generally more motivated (Jones, 2009) and have a more favorable attitude toward the subject taught (Davis, Davis, Smith, & Capa, 2003). Caring relationships can also lead students to perceive their work as meaningful and fun (Davis et al., 2003; Davis, Schutz, Chambliss, & Couch, 2001); and as a result, they benefit both academically and socially (Davis et al., 2001; Davis et al., 2003) and the classroom climate is better (Nichols, 2006). They also develop a stronger sense of control over the outcomes of their work and actions (Skinner, Zimmer-Gembeck, Connell, Eccles, & Wellborn, 1998). In contrast, students, who feel rejected by other students or teachers whom they value or respect, are more likely to become frustrated and distance themselves from the group and their studies.

Cross-cultural research

Etic and emic instrument development. Researchers in the international domain frequently use the *etic* approach to instrument development. In this approach, scales or questionnaires from one country or culture are translated and adjusted to fit another target culture, as opposed to the *emic* approach which requires the developer to design the instrument in the language of the culture (Villagran & Lucke, 2005). The main reason for choosing to translate an instrument is a practical one; namely, it is less time-consuming and costly than developing a new instrument (Church & Lonner, 1998). In addition, the etic approach allows for important cross-cultural comparisons. It is an acceptable practice, especially when the cultures are similar, but the constructs and the context need to be taken into consideration.

Instrument translation. In an instrument translation, the goal or the challenge is to acquire instrument cross-cultural invariance, that is, the scales and tests should be invariant regardless of linguistic and cultural differences (Church & Lonner, 1998; van de Vijver & Leung, 1997; Villagran & Lucke, 2005). Villagran and Lucke (2005) suggest two important criteria to measure the equivalence of the source and the target scale: semantic equivalence and translation invariance. Semantic equivalence deals with the development of the instrument and translation invariance is an assessment of how well the instrument performs when it is used in the intended group.

Semantic equivalence refers to maintaining the denotative and connotative word meanings of the source scale in the translation so that the attributes from the source scale and the target scale are comparable (see also, Beck, Bernal, & Froman, 2003; Behling & Law, 2000; Marin & Marin, 1991). The denotative equivalence refers to the literal and primary meaning of the word, but the connotative equivalence refers to what the word suggests or implies in addition to the meaning. Constructs and their definitions may have different meanings in different cultures. They can also change over a period of time because of economic changes or historical events. The process of translating must take into account the current underlying connotation in addition to the literal meaning of the items. Translators need to make sure that a literal translation will not cause a misinterpretation of the connotative meaning (Beck et al., 2003; Marin & Marin, 1991). *Back-translation* is probably the most common method for translating a scale or instrument (Behling & Law, 2000; Brislin, 1970, 1986) and is generally accepted in cross-cultural research (Villagran & Lucke, 2005). After a bilingual individual translates the scale into the target language, another bilingual translator translates it back into the original language. The original text is then compared to the back-translation and solutions proposed to resolve disagreements. This process is repeated until the translators agree.

The second criterion suggested by Villagran and Lucke (2005) is to assess the *translation invariance*. This is achieved by ensuring that the source and target scales measure the attributes of interest, using psychometric tests. Even when a semantic equivalence of instruments in two languages has been established, one needs to be careful when comparing results from the two groups, the source group and the target group. The differences between the groups' scores could be true, but they might also be a result of a variation in the psychometric properties of the two instruments (Villagran & Lucke,

2005). Statistical tests are used to explore these issues. The assessment or measurement of translation invariance uses the linear item response model (Moustaki & Knott, 2000) or the linear confirmatory factor analysis model (Widaman & Reise, 1997). As suggested by Hambleton (2005), translation equivalence might be a more pertinent term than translation invariance when exploratory factor analysis is employed.

Purpose of study and research question

Of those inventories translated into Icelandic, most have probably been in the field of psychology and counseling (Guðmundsson & Guðmundsdóttir, 2007; Ægisdóttir, Gerstein, & Cinarbas, 2008). As to our knowledge, there are no Icelandic instruments that measure students' motivation-related perceptions. Our goal was to fill this void by providing validity evidence for the Icelandic translation of the MUSIC Inventory. A validated inventory might provide instructors with a clearer idea of how their students perceive factors in the classroom context. Research evidence suggests that instructional strategies can affect a variety of factors related to student motivation (Jones, 2009, 2015). The MUSIC Inventory could help teachers compare the motivational power of the different instructional strategies they use in their classrooms. The inventory has the possibility of being usable for any subject with minor modifications.

Our primary research question was: To what extent does the Icelandic version of the MUSIC® Model of Academic Motivation Inventory (MUSIC Inventory) produce valid scores for Icelandic middle school students in science classes? We used back-translation with a subsequent expert meeting. To assess the validity of the MUSIC Inventory in this context, we examined the inventory scores from middle school students in science classes in five compulsory schools in Iceland.

METHODS

The Virginia Tech Institutional Review Board (IRB) and the Icelandic Data Protection Authority (DPA: S6730, S7352) granted permission for the study. School administrators, teachers, and parents of participants gave their consent, as well as participating students.

First data collection

Participants. For the first data collection, participants were 207 sixth-, seventh- and eighth-grade students (age level 11–13) in two Icelandic public schools. For this convenience sample, the participating schools were recruited through social networking media. Both schools were located in or near the capital, Reykjavík. Of the 207 students, 52 (25%) were from three sixth-grade classes, 12 (6%) students from a class mixed with sixth and seventh graders, 81 (40%) students from four seventh-grade classes, and 59 (29%) students from four eighth-grade classes. About 43% of the students were female. All class periods were a required part of the science curriculum, focusing on topics in physics, biology, and chemistry, based on children's grade level and the Icelandic national curriculum guide for compulsory schools (The Ministry of Education, Science and Culture, 2013).

The classes included students with various special needs who in some cases had an assistant to accompany them.

Instruments. *The MUSIC® Model of Academic Motivation Inventory*. Jones (2012) developed the college student version of the MUSIC Inventory, a 26-item inventory that measures students' perceptions of the prevalence of the five motivation components, eMpowerment, Usefulness, Success, Interest, and Caring (MUSIC) in an academic environment. It was validated by means of empirical evidence through a series of reviews, revisions, and testing with undergraduate college students (Jones & Skaggs, 2016). Because the MUSIC Inventory items were of high caliber, it was possible to shorten the subscales without losing much internal consistency reliability. The shorter 18-item middle and high school version of the MUSIC Inventory (Jones, 2012) was tested empirically and shown to be acceptable for use with US middle school students in science (Jones & Wilkins, 2013b, 2015) and middle and high school students in music and band classes (Parkes et al., 2015). As hypothesized, validity evidence indicated that the five factors were somewhat correlated, yet distinct (Jones & Wilkins, 2013b, 2015; Parkes et al., 2015). The subscales for the middle and high school version include four items for empowerment, three for usefulness, four for success, three for interest, and four for caring. Responses are rated on a 6-point Likert-type scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *mostly disagree*, 4 = *mostly agree*, 5 = *agree*, 6 = *strongly agree*. The subscale score is calculated by averaging the scores of all of the items in the subscale.

Translation procedures for the MUSIC Inventory-Icelandic. The Icelandic version of the MUSIC Inventory (MUSIC Inventory-Icelandic) is a translation of the 18-item middle and high school English version. It consists of five subscales, one for each component of the MUSIC model. We divided the translation procedures into two sections: first the translation and back-translation for semantic equivalence, and subsequently, the completion of psychometric tests to obtain translation equivalence or invariance.

For the process of gaining semantic equivalence between the original version and the translation, both denotative and connotative, we chose to use back-translation, followed by evaluative, expert meetings to resolve differences (Behling & Law, 2000; Brislin, 1970, 1986). This is the most common procedure to translate an instrument and is considered an acceptable method (Villagran & Lucke, 2005). Because of the importance of this process, the translators were carefully selected. All of the translators were bilingual and they had lived in both cultures for extended periods of their lives.

Out of the 18 items in the MUSIC Inventory-Icelandic, 12 items were translated back to English with almost the exact wording of the original version. The other six items were slightly modified and the translation was agreed upon after some discussion among the translators.

Data collection. A female assistant and the first author collected the data. Participants completed the MUSIC Inventory-Icelandic either in their school "home" classroom or in the science lab, a task that took 10–15 minutes. Students were told that they were not obliged to complete the questionnaire, that the researchers were interested in their honest opinions, and that their valuable information would only be used for research purposes and not as part of their school work.

Data analysis. To provide evidence of construct validity for the translated instrument, we performed an exploratory factor analysis (EFA) with the purpose of identifying specific items that might be problematic for revision. As recommended by both Costello and Osborne (2005), and Pedhazur and Schmelkin (1991), we conducted the EFA using Principal Axis Factoring (PAF) with Promax Rotation and Kaiser Normalization. PAF is considered a superior factor extraction method because many default extraction methods, such as Principal Components Analysis (PCA), do not partition unique variance from shared variance so the factor loadings are generally inflated (Costello & Osborne, 2005; Fabrigar, Wegener, MacCallum, & Strahan, 1999). PAF estimates the level of shared variance (communalities) for the items so factor loadings are more accurate. We used Promax Rotation (oblique as opposed to orthogonal) because the MUSIC components have been shown to be correlated and this rotation is appropriate when the factors are expected to be correlated (Costello & Osborne, 2005; Pedhazur & Schmelkin, 1991).

If needed, we planned to make revisions to the MUSIC Inventory-Icelandic based on the results of the factor loadings in the EFA. Tabachnick and Fidell (1996) propose that loadings greater than .32 are adequate in socio-behavioral research. However, our goal was to reach loadings of .50 or higher, which Costello and Osborne (2005) suggest are "desirable and indicate a solid factor" (p. 5).

There are various rules of thumb regarding sample size, such as 5 to 20 subjects per variable (Costello & Osborne, 2005). Costello and Osborne (2005) suggest a ratio of 10/1 as a minimum but recommend a ratio of 20/1. Because the first data collection was used primarily as a preliminary test to perform an EFA with the goal of revising faulty items, we deemed the ratio of 12/1 as acceptable.

Second data collection

Participants. Students from three Icelandic public schools participated in the second data collection. These students were not the same students as those who completed the inventory during the first data collection. The sample was a convenience sample. Participants were 241 fifth- to eighth-grade students (age level 10–13). Out of the 241 students, 79 (33%) were from fifth-grade classes, 73 (30%) from sixth-grade classes, 52 (22%) students from seventh-grade classes, and 37 (15%) students from eighth-grade classes. About half of the students were female and half were male. The focus of the coursework was in accordance with the mandated science curriculum.

Data collection and instrument. Students had about 10–15 minutes to complete the 18-item MUSIC Inventory-Icelandic. They placed their completed inventory in an envelope as they walked out of the classroom. The forms were without names, but included their self-reported gender and age.

Data analysis. To determine the validity of the MUSIC Inventory-Icelandic, we examined three types of validity evidence: internal consistency reliability, construct validity, and discriminant/convergent validity, a subgroup of construct validity.

Internal consistency reliability. We examined internal consistency reliability by computing Cronbach's alpha values for each MUSIC Inventory subscale. Subsequently, we compared the results to those of the original English, middle school version of the MUSIC

Inventory. We used the following criteria to judge the values: alpha values greater than .9 are excellent, between .7 and .9 are good, and between .6 and .7 are acceptable (Kline, 2005).

Construct validity. To establish construct validity, we used confirmatory factor analysis (CFA; George & Mallery, 2003). It should be noted that, as Pedhazur and Schmelkin (1991) explained, construct validity should always take into consideration the definition used in the study (see Table 1). There cannot be any meaningful application of factor analyses without a theory or at least some priori assumptions of the relationship between the variables (Pedhazur & Schmelkin, 1991). Both the original MUSIC Inventory and the Icelandic translation are based on the MUSIC model as the conceptual context, because this builds on theories and research on motivation (Jones, 2009, 2015). Researchers have performed factor analyses for the English versions of the MUSIC Inventory, thus demonstrating that the five constructs could clearly be perceived as statistically distinct (Jones & Skaggs, 2016; Jones & Wilkins, 2013a, 2013b, 2015; Parkes et al., 2015).

We conducted a CFA to test hypotheses for factor structure and model-fit, using inferential techniques and also to provide more informative analytic options. We used LISREL 8.8 to compute the following commonly used fit indices: the Comparative Fit Index (CFI), the Standardized Root Mean Square Residual (SRMR), and the Root Mean Square Error of Approximation (RMSEA). The CFI can vary between 0 and 1 with higher values indicating better fit; for example, values above .90 represent reasonable fit and values close to and above .95 represent good fit (Hu & Bentler, 1999). The SRMR can also vary between 0 and 1, with lower values indicating a better fit. SRMR values less than .05 indicate good fit (Byrne, 2001) and SRMR values less than .10 represent reasonable fit (Kline, 2005). The RMSEA can also vary between 0 and 1 with lower values indicating a better fit; for example, values less than .08 indicate reasonable fit and values less than .05 indicate good fit (Browne & Cudeck, 1993; Byrne, 2001; Kline, 2005).

Discriminant and convergent validity. Discriminant and convergent validity is a subgroup of construct validity. Evidence for this type of validity is obtained through the examination of correlation tables and factor loadings. We assessed the validity by examining the correlations among the MUSIC Inventory-Icelandic subscales. When subscales are distinct, they are not highly correlated among themselves but discriminate; when they converge, they are correlated. Furthermore, the correlations of items across subscales should be lower than the correlations of items within subscales (Thorndike, 1997).

RESULTS

Results of the first data collection

Construct validity. We conducted an EFA using Principal Axis Factoring with Promax Rotation and Kaiser Normalization. The .001 value for the determinant of the correlation matrix was acceptable, the .84 value for the *KMO* (Kaiser-Meyer-Olkin) measure of sampling adequacy was very good (Kaiser, 1970, Kaiser & Rice, 1974), and Bartlett's test of sphericity was statistically significant ($\chi 2 = 1425.8$; $df = 136$; $p < .001$). All of these values were

acceptable, which indicated that the values in the pattern matrix could be interpreted. The five components explained 66.4% of the variance with factor 1 contributing 35.4%, factor 2 contributing 10.5%, factor 3 contributing 8.0%, factor 4 contributing 7.3%, and factor 5 contributing 5.3%.

The pattern matrix is shown in Table 2. Overall, the results were quite good, as evidenced by several findings. First, all of the items except one had the highest loading on the factor with the other items in the same subscale (denoted by the boldface numbers in Table 2). That is, all of the caring items loaded highest on Factor 1, two of the three usefulness items loaded highest on Factor 2, all of the success items loaded highest on Factor 3, all of the empowerment items loaded highest on Factor 4, and all of the interest items loaded highest on Factor 5. Second, all but two of the items loaded with other items in their subscale with a loading greater than 0.32, which is often used as a cutoff for acceptability (Tabachnick & Fidell, 1996). Third, the loadings on the "off" factors were very low in most cases and 63 out of 68 (93%) of the off factors were less than 0.2.

Table 2. Pattern matrix for the EFA, all variables included, using PAF with Promax Rotation

	Factors				
	1	2	3	4	5
C3	**.78**	-.03	-.12	-.04	.16
C2	**.75**	-.02	-.08	.09-	.00
C1	**.61**	-.07	.20	-.13	-.05
C4	**.26**	.19	-.07	.09	.08
U3	-.04	**.99**	.03	-.04	-.04
U2	-.06	**.84**	-.06	.01	.02
S2	-.11	.03	**.91**	-.04	.08
S4	-.10	-.07	**.57**	-.02	.38
S3	.18	-.06	**.57**	.13	-.06
U1	.13	.30	**.33**	.04	.04
M4	.06	-.00	.07	**.71**	-.12
M1	-.20	-.05	-.15	**.70**	-.23
M2	.09	.00	.14	**.59**	-.11
M3	.13	.19	.02	**.33**	.07
I2	-.04	.00	.05	.12	**.81**
I1	.24	.14	.00	-.14	**.55**
I3	.11	-.10	.19	-.01	**.54**

Note. Boldface indicates the highest pattern coefficient for each item

Based on our goal to obtain factor loadings close to or greater than .50, we targeted four items for possible re-wording: M3, U1, S3, and C4. Following an expert meeting, the first author discussed and tested the new items with four fifth- to eighth-grade students on two different occasions, two at a time. Some suggestions from the students were discussed at a second meeting of translators and the revision was completed. The results are described in the following sections.

M3 item. The M3 item loaded lower (.33) than our goal of .50. Problems with this item did not come as a complete surprise. The translation of the item had been identified in one of the earlier translation meetings as perhaps too formal, especially the Icelandic word for goal, *markmið*. Also, during the first data collection, some students asked for assistance with this item. The original M3 item read: I have options in how to achieve the goals in science class (in Icelandic: Ég hef ýmsa möguleika á því hvernig ég næ markmiðum í náttúrufræðitímum). This item was revised as: Ég get klárað vinnuna í náttúrufræðinni á ýmsan hátt (in English: I can complete my science work in several ways).

U1 item. The EFA showed that the U1 item cross-loaded between two factors, usefulness and success, one under .32, and the higher number (.33) under the wrong subscale. The original item read: In general, science class work is useful to me (in Icelandic: Vinnan í náttúrufræðitímanum er gagnleg fyrir mig.). This item was revised to: Mér finnst ég almennt hafa gagn af því sem ég er að læra í náttúrufræðinni (in English: The things I am learning in science are, generally, useful to me.).

S3 item. The S3 item did load above 50; however, it seemed to confuse some students as they were filling out the questionnaire. It was also an item that had required the most discussion in the initial meeting with the translators. The original read: I feel that I can be successful in meeting the academic challenges in science class (in Icelandic: Mér finnst ég geti skilað því af mér sem er ætlast til af mér í náttúrufræðinni). We revised it to: Mér finnst ég geti ráðið við það sem ég á að gera í náttúrufræði (in English: I feel that I can manage what I am supposed to do in science).

C4 item. The C4 item loaded with the other caring items, but the value was low (0.26). The original item read: My science teacher cared about how well I did in science class (in Icelandic: Það skipti kennarann minn máli hvernig mér gekk í tímanum). It is not clear why this item did not load well. It seemed understandable to us, but we decided to simplify it. The revised item read: Náttúrufræðikennarinn minn vill að mér gangi vel í tímum (in English: My science teacher wants me to do well in science class).

The new and revised version was used in the second data collection (see an example of items in Table 3).

Table 3. Examples of items from the Icelandic version of the MUSIC® Model of Academic Motivation Inventory

MUSIC model subscales	Examples of items
Empowerment	M3 Ég get klárað vinnuna í náttúrufræðinni á ýmsan hátt M4 Ég ræð því hvernig ég vinn með eða læri námsefnið
Usefulness	U1 Mér finnst ég almennt hafa gagn af því sem ég er að læra í náttúrufræðinni U2 Það sem ég læri í náttúrufræðitímum er mikilvægt fyrir framtíð mína
Success	S3 Mér finnst ég geti ráðið við það sem ég á að gera í náttúrufræði S4 Ég er viss um að ég get náð góðum árangri í náttúrufræði.
Interest	I1 Ég hef áhuga á námsefninu í náttúrufræði I3 Vinnan í náttúrufræðinni heldur athygli minni
Caring	C1 Náttúrufræðikennarinn er tilbúinn að hjálpa mér ef ég þarf á hjálp að halda C3 Náttúrufræðikennarinn minn er vingjarnlegur

Note. The full version of the Icelandic version of the MUSIC Inventory is available at Jones (2016)

Results of the second data collection

Internal consistency reliability. The internal consistency of the items within each subscale, measured with Cronbach's alpha, was *acceptable* for empowerment and *good* for the other subscales (Kline, 2005): empowerment α = .68; usefulness α= .87; success α = .83; interest α = .86; and caring α = .88. A comparison with the internal consistency of the original version (Jones & Wilkins, 2013b) is provided in Table 4. These high alpha values indicate that the items within each subscale are highly positively correlated. They appear to display adequate levels of internal consistency similar to those obtained with the original version of the scale.

Table 4. Internal consistency reliability comparison of Cronbach's alpha values

MUSIC Inventory subscale	Original	Icelandic translation
Empowerment	.72	.68
Usefulness	.80	.87
Success	.84	.83
Interest	.77	.86
Caring	.85	.88

Note. The alphas from the original middle and high school version originate from Jones, Sahbaz, and Chittum (2015)

Construct validity. We conducted a CFA to examine how the items in the MUSIC Inventory-Icelandic fit the five-factor structure of the MUSIC model. We used the completely standardized solution for the factor structure and model-fit. The data fit the model well, with the following values indicating that it was a good fit: CFI = 0.98 (0-1, where closer to 1 is better; Hu & Bentler, 1999), RMSEA = 0.05 (0-1, where < .05 is good and < .08 is reasonable; Browne & Cudeck, 1993; Byrne, 2001, Kline, 2005), and SRMR = 0.05 (0-1, where < .05 is good, and < .1 is reasonable). Figure 1 shows the model tested and Table 5 shows the standardized solution computed for the CFA. The factor loadings were acceptable and ranged from 0.44 to 0.90. Of the 18 items, only four items were under .72.

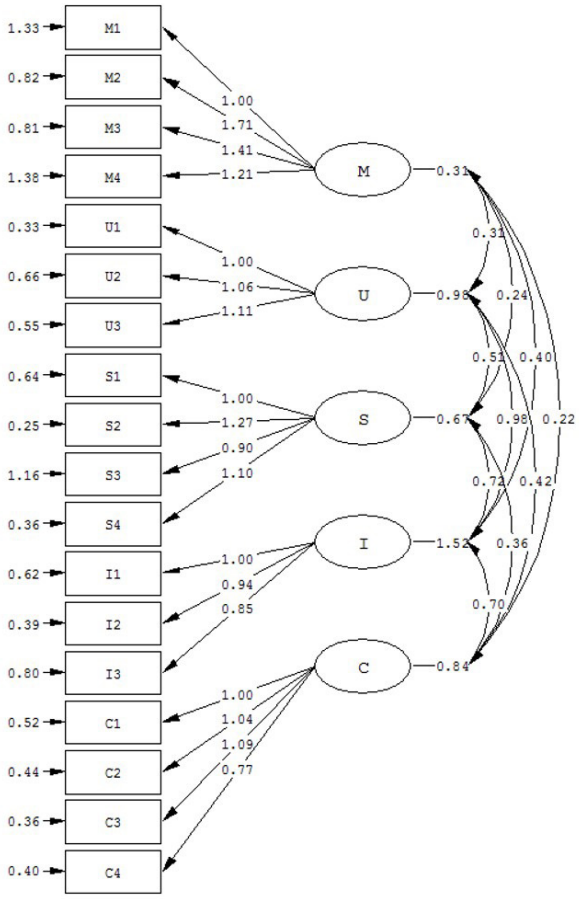

Figure 1. Results of the five-factor model that we tested using confirmatory factor analysis

Table 5. Factor loadings from the CFA – Completely Standardized Solution

Item	M	U	S	I	C
M1	0.44				
M2	0.73				
M3	0.66				
M4	0.50				
U1		0.86			
U2		0.79			
U3		0.83			
S1			0.72		
S2			0.90		
S3			0.56		
S4			0.83		
I1				0.84	
I2				0.88	
I3				0.76	
C1					0.78
C2					0.82
C3					0.86
C4					0.75

Note. The following abbreviations are used: M = eMpowerment, U = Usefulness, S = Success, I = Interest, and C = Caring

Discriminant/convergent validity. Even though the CFA indicated statistically that the data fit the model, it is helpful to examine the correlations among the subscales as well as the correlations among the items. Table 6 shows the correlations among the five subscales. They were moderately correlated as was expected which is consistent with prior studies (e.g., Chittum, 2015; Jones & Wilkins, 2013b) as is shown by the values in parentheses in Table 6 from the Chittum (2015) study of fifth-, sixth-, and seventh-grade students in science classes.

Table 6. Correlations (Pearson's) of the Five MUSIC constructs and descriptive statistics

	1	2	3	4	5
1. eMpowerment		.39 (.58)	.40 (.48)	.44 (.61)	.32 (.38)
2. Usefulness			.54 (.46)	.69 (.70)	.41 (.28)
3. Success				.63 (.61)	.43 (.64)
4. Interest					.56 (.44)
5. Caring					
Mean	3.8	4.4	4.6	4.2	5.2
SD	0.9	1.1	1.0	1.2	1.0

Note. All correlations are significant at the 0.01 level (2-tailed). Values in parentheses are from the English version of the MUSIC Inventory (Chittum, 2015). Likert scales ranged from 1–6

Table 7 shows Pearson's correlations between all the items. As hypothesized, the correlations were positive and mostly statistically significant. Most of the items had a moderate correlation as they did in the English version. The correlations were generally lower between items of separate subscales than items within the same subscale. Even though correlations between some items were somewhat high, the results from the CFA indicated that statistically the items in the same subscale correlated higher among themselves than with ones in the other subscales.

Table 7. Pearson correlations among the 18 items in the five subscales

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. M1	-	.38**	.21**	.29**	.16*	.16*	.16*	.16*	.09	.01	.12	.17**	.19**	.20	.12	.22**	.14*	.09
2. M2		-	.44**	.40**	.33**	.33**	.37**	.36**	.30**	.22**	.28**	.30**	.33**	.35**	.22**	.32**	.27**	.20**
3. M3			-	.32**	.44**	.33**	.38**	.39**	.41**	.41**	.43*	.34**	.45**	.38**	.19**	.20**	.23**	.21**
4. M4				-	.15*	.10	.13*	.14*	.11	.12	.13*	.16*	.26**	.22**	.11	.23**	.24**	.13
5. U1					-	.69**	.70**	.37**	.50**	.30**	.53**	.59**	.63**	.56**	.34**	.33**	.35**	.33**
6. U2						-	.68**	.32**	.36**	.26**	.46**	.48**	.53**	.49**	.26**	.30**	.28**	.34**
7. U3							-	.38**	.46**	.32**	.50**	.55**	.61**	.52**	.26**	.29**	.29**	.38**
8. S1								-	.65**	.41**	.60**	.42**	.42**	.31**	.23**	.21**	.26**	.31**
9. S2									-	.50**	.76**	.59**	.55**	.45**	.33**	.35**	.37**	.37**
10. S3										-	.43**	.47**	.48**	.39**	.29**	.28**	.33**	.33**
11. S4											-	.47**	.48**	.46**	.25**	.28**	.29**	.37**
12. I1												-	.76**	.62**	.44**	.39**	.43**	.42**
13. I2													-	.66**	.41**	.42**	.41**	.45**
14. I3														-	.42**	.45**	.45**	.43**
15. C1															-	.63**	.67**	.61**
16. C2																-	.72**	.60**
17. C3																	-	.62**
18. C4																		-

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed)

Note. The following abbreviations are used: M = eMpowerment, U = Usefulness, S = Success, I = Interest, C = Caring

DISCUSSION AND IMPLICATIONS

The purpose of this study was to translate the middle and high school version of the MUSIC Inventory from English to Icelandic and adapt it for use with middle school students in Iceland. Our primary research question was: To what extent does the MUSIC Inventory-Icelandic produce valid scores for Icelandic middle school students in science classes? To answer that question, we collected data at two time points using the MUSIC Inventory-Icelandic. The results of the reliability and factor analyses suggest that the instrument is valid for use with this population of students.

The Cronbach's alpha values for each MUSIC Inventory-Icelandic subscale were acceptable, thus providing evidence for the internal consistency and the stability of the scores

on the subscales. All alpha values but one were over .80, a value that is exemplary (Robinson, Shaver & Wrigtsman, 1991). One subscale had an alpha value of .68, which is still considered to be good (Kline, 2005). These findings indicate that the items within each subscale were highly correlated, which is a necessary condition for internal consistency.

The EFA produced from the first data analysis provided good results. Two items, however, had loadings under .40 and one item cross-loaded on two factors. Even though some experts have indicated that .32 is acceptable as a cutoff in socio-behavioral research (Tabachnick & Fidell, 1996), others have suggested that loadings exceeding .4 or .5 are more meaningful (Costello & Osborne, 2005; Pedhazur & Schmelkin, 1991). As our goal was to reach a factor loading closer to .5 for each factor, similar to the original version of the MUSIC Inventory, we revised these three items, as well as one additional item that had caused some confusion among the participants during data collection.

We performed a CFA on the second data set, which derived from a second group of participants completing the revised MUSIC Inventory-Icelandic. The CFA demonstrated that the five-factor model was a good fit to the data, based on a CFI of .98, a good fit, and very similar to the results of the original English inventory. In addition to confirming the model fit, the CFA confirmed the discriminant and convergent validity of the items and factors. Only the M1 item had a value under our cutoff coefficient of .5, although it was not too far below it at .44. Correlations among the subscales indicated discriminant and convergent validity, as did the correlations of the items, where the items across subscales correlated less among themselves than the items within each subscale.

In addition to providing validity evidence for the MUSIC Inventory-Icelandic, this study also provides further evidence for the MUSIC Model of Motivation in a non-U.S. culture. The fact that the CFA confirmed the acceptability of the five-factor MUSIC model indicates that, like U.S. students, Icelandic students also differentiate their perceptions of an instructional environment into at least these five MUSIC factors. These findings suggest that these five factors may be universal among students. Future studies could examine whether the five-factor structure of the MUSIC model is consistent across other cultures as well.

Uses of the MUSIC Inventory-Icelandic and future research

The results of the reliability analysis and factor analyses provide strong evidence for the validity of the scores produced by the MUSIC Inventory-Icelandic. These are encouraging results because an instrument that measures the motivation of Icelandic students could be a valuable tool for Icelandic teachers and educators as well as researchers. It might, for example, be used to compare motivation levels in various teaching environments, such as teacher-centered versus student-centered classrooms. Several studies indicate that compared to teacher-centered strategies, student-centered strategies (especially inquiry strategies) are more likely to motivate students to engage in learning. The results of such studies could inform educational policy in Iceland and possibly increase student motivation.

Another area for investigation that we find intriguing is the stability of students' perceptions over time, from one completion of the inventory to another. It might be possible

to perform a test-retest reliability analysis, which could provide evidence related to the temporal stability of the results. It is hard to know how stable students' perceptions are even if the course strategies remain similar. Administering the inventory throughout a year would allow researchers and teachers to determine how much students' perceptions changed over time.

For teachers, the inventory results could guide the design and development of their classroom strategies. Motivation factors and the interplay between them are complex (Jones, 2009, 2015). Some factors can be difficult for teachers to address, but many classroom factors can be influenced through the strategies that the teacher adopts. Research has shown that teaching strategies that incorporate empowerment, usefulness, success, interest, and caring increase motivation (Jones, 2009). The results of the MUSIC Inventory-Icelandic could be used to directly identify which of these five MUSIC components were lowest and then teachers could identify strategies related to these lowest MUSIC components. For example, the results of the MUSIC Inventory-Icelandic could alert the teacher to the extent to which students perceived empowerment in the classroom or whether the teacher's efforts to portray the usefulness of students' studies had been successful. The teacher could have students complete the inventory soon after the beginning of the school year, use the responses to inform his or her instruction, and, subsequently, repeat the process later in the year to examine any changes in students' MUSIC-related perceptions.

Teachers are also researchers and evaluators of their own success. The MUSIC Inventory-Icelandic could enable teachers to evaluate and understand the factors that influence motivation in their classrooms so they can modify their teaching environment as needed. Students are more motivated when they perceive that they have some choices, when they see the usefulness of their efforts, when they are interested in the task at hand, when they feel that they can be successful, and when they feel cared for in the classroom environment (Jones, 2009). The MUSIC Inventory guides teachers in the process of determining where the need is for improvement.

Finally, although the wording in the inventory was aimed at science students, it is possible that the inventory may produce valid scores when the word "science" is replaced with another subject, as has been demonstrated in the English version of the MUSIC Inventory (e.g., "science" was replaced with "music" in Parkes et al., 2015). Thus, the implications for using this inventory could extend to other subjects beyond the discipline of science.

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