Validating an Icelandic version of the MUSIC^{SM} Model of Academic Motivation Inventory

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ABSTRACT

Students' motivation generally declines during the middle school years, a period of time when important foundations for further studies are laid. There is a move in many countries to improve science education, especially science literacy that is inadequate according to international research (Halldórsson, Ólafsson, & Björnsson, 2007, 2013). The subject of this dissertation is the translation and validation of the MUSIC^{SM} Model of Academic Motivation Inventory (MMAMI; Jones, 2012) from English into Icelandic. The purpose for the translation is to provide Icelandic educators with a tool to assess students' motivation in the science classroom. Motivation in the classroom is a complex issue in which both cognitive and contextual factors are involved. The information gained from the inventory responses could be used to guide the development or modification of the classroom strategies employed. The inventory measures students' perceptions of the five components of the MUSIC^{SM} Model of Academic Motivation: e**M**powerment, **U**sefulness, **S**uccess, **I**nterest and **C**aring, components that have been found to be influential to student motivation (Jones, 2009). The model is based on a thorough analysis of motivation theories and research. The inventory was developed for middle school students in science classes, although it can easily be modified to fit any subject. Back-translation followed by expert meetings was used to gain semantic equivalence. Participants were 458 middle school students in science classes in five public schools in Iceland. To obtain translation invariance in the first version of the translation, I used an Exploratory Factor Analysis (EFA) on one data set, using Principal Axis Factoring with Promax Rotation, to examine the translated items. Subsequently, I implemented a Confirmatory Factor Analysis (CFA) on a second data set to test for model fit. The results replicated the findings obtained with the original version and confirmed the five-factor structure of the MMAMI. All factor loadings were significant. The reliability analysis, using Cronbach's alpha, also replicated the good and acceptable alpha ratings of the original instrument. These findings provide validity evidence for the scores produced by using the Icelandic version of the MMAMI with middle school Icelandic students in science classes.

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Commonly-used Acronyms

MMAMI: The MUSIC Model of Academic Motivation Inventory

CFA: Confirmatory Factor Analysis

EFA: Exploratory Factor Analysis

PAF: Principal Axis Factoring

PCA: Principal Components Analysis

CFI: Comparative Fit Index

SRMR: Standardized Root Mean Square Residual

RMSEA: Root Mean Square Error of Approximation

NRC: National Research Council

Chapter 1: Introduction

Rationale

A strong relationship exists between motivation and learning (Schunk, Pintrich, & Meece, 2008). Motivated students engage in their studies and usually achieve higher academically than unmotivated students. Unfortunately, many students lack motivation, and educators are often faced with the challenging task of trying to maintain their motivation. Motivation in the classroom is a complex issue in which both cognitive and contextual factors are involved. Because of this complexity, it can be difficult for teachers to measure and 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 (Jones, 2009).

The MUSIC[SM] Model of Academic Motivation Inventory (MMAMI; Jones, 2012) could be a useful tool to help educators, researchers, and instructional designers assess students' motivation. The inventory is based on the MUSIC[SM] Model of Academic Motivation (Jones, 2009) that was developed after a thorough analysis of motivation theories and research. It comprises five key components that researchers have found critical to students' motivation in the classroom: e**M**powerment, **U**sefulness, **S**uccess, **I**nterest, and **C**aring (MUSIC). According to the research on which the model builds, motivation increases when students perceive that they have some choices in the way they learn (i.e., *empowerment*), when they see *usefulness* or value in their learning, when they believe that they can be *successful*, when situational *interest* or enjoyment is triggered in the classroom, and when students feel *cared* for in the classroom environment. Jones' purpose in developing the MMAMI 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 MMAMI and Jones and Skaggs (in press) validated it for use with university students. Jones (2012) also developed a shorter version for use with middle school students in science and it has been shown to produce valid scores for this population (Jones & Wilkins, 2013b, 2015). Students are asked to rate their perceptions of the presence of five factors (i.e., empowerment, usefulness, success, interest and caring) in the classroom context. Because each MMAMI subscale corresponds to one of these five MUSIC factors, instructors can utilize the scores to focus on the improvement or modification of their instruction and classroom management. The MMAMI has mainly been used in the US, although it was translated into Arabic and has been validated for use in that culture with college students (Mohamed, Soliman, & Jones, 2013).

The main goal of this dissertation was to translate the MMAMI from English into Icelandic and to validate the scores produced by the Icelandic version. As far as I know, there are no Icelandic instruments to assess student motivation. I selected the middle school version of the MMAMI because of my interest in middle school students, my personal experience as a teacher for this age group, and the sudden decline in motivation they often experience according to research. Furthermore, I decided to focus on science students because of the attention the apparent lack of adequate science literacy in compulsory schools in many countries, including Iceland, is gaining (Halldórsson, Ólafsson, & Björnsson, 2007, 2013; National Research Council [NRC], 2007, Osborne, 2003). There is a perceived need to improve science education. The translated inventory could be helpful to Icelandic educators in assessing students' motivation. It might also be useful in future research in the field of student academic motivation.

Student Academic Motivation

Motivation has been defined as: "the process whereby goal-directed activity is instigated and sustained" (Schunk et al., 2008, p. 4). As such, it is a process where individuals make choices about whether or not to act. Thus, motivation leads to action or engagement. If students lack motivation they are not likely to be engaged in their studies. Motivated students are engaged, tend to persist when faced with challenges and are often successful (Stipek, 1993). Student motivation increases the possibility of deeper meaningful learning and thus, academic achievement (Ames, 1992).

At a young age, children are usually curious and motivated to learn about their surroundings (Kushnir, 2009) and most often they start school full of optimism and excitement for new experiences (Björnsdóttir, Kristjánsson, & Hansen, 2008). However, motivation in several subjects has a tendency to decrease substantially as students get older, especially in the early years of secondary school (Ferguson & Fraser, 1998; Goodrum, Hackling, & Rennie, 2001; NRC, 2007). Furthermore, motivational variables such as students' level of interest (Björnsdóttir et al., 2008; Osborne, 2003), positive attitude, and engagement in subjects tend to decline during these years (Bennett & Hogarth, 2009; Martin, Mullis, & Foy, 2008; Osborne & Collins, 2001). The focus of this study is on the middle school years, a time that is rather pivotal in children's development. Exploring motivation in middle school is not a simple matter. In addition to several school and classroom factors, various biological and relational changes influence students' lives at this age, changes that also play a role in students' well-being and success in the school context (Davis, 2006; Eccles et al., 1993; Eccles & Wigfield, 2002). As children develop more independence from parents, relationships with friends become increasingly important and peer pressure grows. Physical changes, various levels of self-esteem, and life's experiences also play

a role. These factors have been found to affect children's academic motivation and attitude towards school and school subjects (Davis, 2006). Lack of academic motivation in middle school can be harmful because during these years important foundations for further studies are laid. It can result in a gap in students' foundation, a gap that may complicate students' continued studies and future motivation (Hidi & Harackiewicz, 2000).

In the United States as in many other countries, there is a widespread concern among educators and policy makers about the lack of motivation many students seem to experience in the science classroom in compulsory schools (NRC, 2007, Osborne, 2003). Educators are also concerned about the decline in the number of students who choose science courses in high schools (Cleaves, 2005) and science degree programs in college since the future work market will increasingly need people with science backgrounds (President's Council of Advisors on Science and Technology [PCAST], 2012). Research data from the Programme for International Student Assessment (PISA) indicate that students in many countries, including the United States and Iceland, experience a low level of motivation in science and lack adequate scientific literacy (Halldórsson et al., 2007, 2013; Organisation for Economic Co-operation and Development [OECD], 2014). PISA is a world-wide assessment on 15-year-old students' performance in science, math, and reading by OECD with the goal of improving education policy and outcome. One of the goals of science education is to provide students with basic scientific literacy, that is, a general understanding of socio-scientific issues and how to use the most necessary technology (Murcia, 2009). Educators worry that without experiencing motivation in the classroom, students will not learn what they need to be able to participate as fulfilled and contributing citizens in a technological society. Furthermore, science education in compulsory schools is expected to build a foundation for students' further studies in science and engineering, as the workforce calls for

more employees in these fields (PCAST, 2012). Without the motivation to study, students' foundational knowledge in science will be weak and they will be less likely to choose and be successful in science courses.

Research on student motivation in the science classroom in Iceland is rather limited. Some data regarding the motivation of 10th grade students derive from a few items on inventories from PISA (OECD, 2014). As to my knowledge, there is even less information regarding middle school students in science. Results from PISA have indicated that 10th grade Icelandic students have rated just moderately on these motivational factors (Halldórsson et al., 2007, 2013). Furthermore, results from PISA 2013 show a decline in students' achievement scores in scientific literacy from the PISA study results in 2007. This has led to an interest in finding ways to increase Icelandic students' motivation in the science classroom.

Purpose of Study and Research Question

The primary purpose of this study was to answer the following research question: To what extent does the Icelandic version of the MUSIC[SM] Model of Academic Motivation Inventory (MMAMI-Icelandic) produce valid scores for Icelandic middle school students in science classes? To assess the validity of the MMAMI-Icelandic in this context, I examined the inventory scores from middle school students in science classes in five compulsory schools in Iceland.

Research instruments developed in one country or culture are frequently translated and validated for use in another country (Villagran & Lucke, 2005). It is both less time-consuming and less expensive than creating a new instrument. In addition, translated education research instruments provide possibilities for cross-cultural comparisons that reveal the strengths and

weaknesses of nation's educational systems, and as such, give valuable information for modification and improvement.

Some inventories have been developed in Icelandic and others have been translated from languages of other Western cultures into Icelandic. The translations have primarily been in the field of psychology and counseling (Einarsdóttir, Eyjólfsdóttir, & Rounds, 2013; Guðmundsson & Guðmundsdóttir, 2007). But, as to my knowledge, there are no Icelandic instruments that measure students' motivation. My goal was to fill this void by providing validity evidence for the Icelandic translation of the MMAMI for middle school students in science, and thus, provide educators and researchers with a tool to assess students' motivation. A validated inventory might provide instructors with a clearer idea of how their classroom strategies influence students' perceptions of their classroom experiences, and how these in turn influence student motivation. Research evidence suggests that instructional strategies can affect a variety of factors related to students' motivations (Jones, 2009). The MMAMI could help teachers compare the motivational power of the different instructional strategies they use in their classrooms. In the long run, it might also help science educators find a way to attract more middle school students to the study of science (Jones, Ruff, & Osborne, 2015). If the use of research-based teaching strategies that possess important motivation elements could create or maintain students' motivation and create more interest in science during middle school, students might acquire better basic scientific literacy, and possibly pursue science-related careers. Finally, the inventory has the possibility of being usable for any subject with minor modifications. My hope is that it will be a practical and user-friendly tool for both teachers and researchers in Iceland.

Dissertation Outline

This dissertation has five chapters. In this chapter, Chapter 1, the introduction, I described the topic of this dissertation, the background context, the purpose, and the research question for the study. In Chapter 2, the literature review, I recount the literature that guided my translation process as well as the motivation research that influenced the framework of my study. Chapter 3 comprises the methodology section where I detail the translation procedures of the MMAMI (semantic equivalence) and the psychometric testing needed to ensure the reliability and the validity of the translation (translation invariance). This chapter also describes the participants, the instruments, and the detailed process of the translation and validation. In Chapter 4, I present the results. The last chapter, Chapter 5, contains the discussion and conclusions.

Chapter 2: The Review of the Literature

Transcultural Research

Emic or Etic 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, that it is less time-consuming and costly than to develop a new instrument (Church & Lonner, 1998). In addition, the etic approach, i.e., the cross-cultural translation and adaptation of tools, allows for an important comparison cross-culturally. The etic approach is an acceptable practice, especially when the cultures are similar, but the constructs and the context need to be taken into consideration. Common topics for translated instruments include assessment of personalities, values and beliefs, emotions, well-being, and motivation (Church & Lonner, 1998).

In some cases, instruments such as questionnaires, interviews, and personality measures are not transportable from one culture to another (Church & Lonner, 1998; Paunonen & Ashton, 1998; Triandis, 1994). In these instances, it is important to use the emic approach (i.e., to develop the instrument in the language of the country or culture). This is a method that requires the careful mapping of the target culture's characteristics or "indigenous personality constructs" (Church & Lonner, 1998, p. 34) in a more deductive manner, that is, the scales are developed from the general observations to the specifics. It requires the researcher or the designer of the

instrument to stay in the target country and absorb its culture and characteristics for a considerable period of time.

Issues in Transcultural Research

It is important to realize that a culture can play an important role in research, not the least in studies on personality measures that influence the expression of values and beliefs. It has the potential of changing or at least modifying the type of inferences that can be made from the results of cross-cultural research. Some countries in Asia have, for example, been found to have several cultural differences to the US (Church & Lonner, 1998; Markus & Kitayama, 1991, 1998). Asian individuals often respond differently to personality measures, for example measures concerning the focus on the self. Some researchers suggest that peoples' attitude regarding individualism versus collectivism can be measured on a continuum (Ghorpade, Hattrup, and Lackritz, 1999). The US and Western Europe generally fall closer to the individualist side but Asian and Latin American nations are more collectivist (Hofstede, 1991; Kim et al., 1994; Triandis, 1994). Hofstede (1980, 1991) reported that on a collectivist to individualistic scale from 0 - 100, US scored 91, but India and Japan scored 48 and 46, respectively. This can influence the way people from these nations rate items on questionnaires.

Some participants from collectivist cultures tend to conceptualize items regarding self-esteem differently than participants from Western cultures (Shweder, 1991). In their research on the measurement equivalence of some psychological measures, Ghorpade et al. (1999) reported that models for self-esteem and need for higher order strength did not work for an Indian female sample the same way as it did for Indian males, and males and females from the US. The female's answers suggested that not only did they tend to be more collectivist than the other groups, but they also indicated that the females were strongly socialized into traditional feminine

roles in which they perceived they were expected to stay. They seemed to experience guilt when they violated norms. Similarly, Hui and Triandis (1989) found that the cultural tendency of wanting to be socially accepted influenced participants' responses as they considered neutral responses more polite. They did not want to seem extreme or proud. Yet, there are cultures that consider extreme responses more sincere. In these cases, the scores from the translated inventory might not reflect the true characteristics of the individuals.

Another characteristic that can considerably influence responses is participants' locus of control, that is, their attribution of external or internal causes to outcomes (Church and Lonner, 1998; Ghorpade et al., 1999; Markus & Kitayama, 1991, 1998). Some cultures believe in fate. They believe that someone else, such as a higher power, controls their lives. This is a common belief in religions such as Hinduism but some other religious groups in the Western world share this belief.

Because of the complexity of cultures, the etic approach, the translation process, requires a careful deliberation. It is important to empirically demonstrate the equivalence of instruments used before drawing inferences about groups of people (Church & Lonner, 1998). When the cultures are similar, the translating process is less complicated, and the instrument can be accepted as relatively bias-free, that is, psychologically, linguistically, and in general, culturally appropriate. In other instances, major adaptations may be necessary (van de Vijver & Leung, 1997; van de Vijver & Poortinga, 2005; Ægisdóttir, Gerstein, & Cinarbas, 2008).

Cultural Differences and Similarities between the US and Iceland

As highly developed Western cultures, Iceland and the US share many cultural similarities, such as customs and values. There are however some significant differences, such as the political and educational systems (Statistics Iceland, 2014). While the US is built on a more

capitalistic ideology, Iceland is a republic with a parliamentary democracy and presidential elections by a popular vote; it is also defined as a Welfare State, similar to the other Nordic countries due to its welfare system that includes a socialized health insurance. Iceland has a relatively high standard of living, education, and prosperity in spite of the 2008 recession. The rate of material deprivation for the population was 6.4% in 2013. In 2012, Iceland had the 6th lowest rate of material deprivation in the world (Statistics Iceland, 2014). The country has a small population of about 315,000 inhabitants of which almost two-thirds (209,000) reside in and around the larger municipal area of Reykjavik, the capital (Statistics Iceland, 2014).

The organization of education in Iceland is more centralized than in the US. The system is divided into four levels: the first level is preschool up to five years of age, the second level is compulsory education (primary and lower secondary in a single structure) for students from six to 16 years, and the third level is the upper-secondary for students from 16 to 20 years old who graduate with matriculation, having completed all general or core requirements (Ministry of Education, Science, and Culture, 2002). Matriculation is required for University, the fourth education level. A Bachelor´s degree requires three to four years of study. Compulsory schools are almost all within the public sector, each serving the corresponding neighborhood. The few small private schools that exist in Reykjavik also receive public funds. Everyone has the right to an education, regardless of socioeconomic status, gender, religion, background, or handicap. Education is free, including public university education that only requires a small, yearly fee. However, private universities require tuition. With the exception of a few specialized schools, all education is under the jurisdiction of the Ministry of Education, Science, and Culture that issues the National Curriculum Guidelines, providing the objectives necessary to implement the law (Ministry of Education, Science, and Culture, 2002). However, the operation of the pre-schools,

as well as the compulsory and the lower secondary schools, is in the hands of the local government. Students with special needs are included in the public schools of the neighborhoods in which they live. Most public schools are relatively similar with regards to socioeconomic status, teacher preparation and background, and general structure, although there is ample freedom within each school to develop a specific school culture, and emphasize certain subjects, such as music, sports, or science, over other subjects. The general, stated purpose of mandatory education is to prepare students to participate in a democracy. Thus, "liberal," Christian values, tolerance, and democratic cooperation lead the way. Educational material is published by the National Center for Educational Materials and distributed to the compulsory schools. The Educational Testing Institute, which is independent (albeit funded by the state), organizes and grades national examinations, as well as participating in comparative analyses through international questionnaires (Ministry of Education, Science, and Culture, 2002). Education research has indicated that students and teachers in Iceland face very similar challenges to those in the U.S. For example, students' academic motivation and interest tends to decrease with age, especially at the early secondary level (Björnsdóttir et al., 2008).

Questionnaires from Western cultures, including the US, are commonly translated into Icelandic and adapted to the culture. Instruments already translated include, for example, career thoughts (Björnsdóttir, Kárdal, & Einarsdóttir, 2010), personality inventories (Björgvinsson & Thompson, 1996), and checklists on children' problem behavior (Guðmundsson & Guðmundsdóttir, 2007). Translated questionnaires generally yield acceptable evidence to confirm that the instruments are cross-culturally equivalent (Ægisdóttir et al., 2008). As an example, Björgvinsson and Thompson (1996) compared results from an Icelandic translation of the Basic Personality Inventory (Jackson, 1989), a 240-item measure of psychopathology, to the

results of the original English version. A group of Icelandic graduate students studying in North America (bilingual) completed both versions, the original English version and the Icelandic translation. Psychometric testing confirmed that the Icelandic translation was adequate for use.

Researchers have also investigated the cultural similarities and differences in the two nations' range of interest. Einarsdóttir et al. (2013), for example, compared Icelandic interest scales developed through the emic approach (not a translation) to American interest scales. The comparison revealed that the majority of the scales in the Icelandic questionnaire were similar to the US Strong Interest Inventory Basic Interest Scales (Donnay, Morris, Schaubhut, & Thompson, 2005) and Basic Interest Markers (Liao, Armstrong, & Rounds, 2008). However, some fields of interest were culturally relevant to one nation but not the other, such as some religious, military, and family activities (Einarsdóttir et al., 2013). This suggests that religious activities play a larger role in the American culture. Furthermore, the US participates in an extensive military operation where Iceland has none, and American families are involved in sports that are not popular in Iceland, such as baseball and football. In general, prior research suggests that it is relatively accurate to assume that the two cultures are similar enough for the etic approach.

Instrument Translation

In an instrument translation, the goal or the challenge is to acquire instrument cross-cultural equivalence, that is, the invariance of scales and tests, in spite of linguistic and cultural differences (Villagran & Lucke, 2005; Byrne & Watkins, 2003; Church & Lonner, 1998; van de Vijver & Leung, 1997). Villagran and Lucke (2005) suggest two important criteria to measure the equivalence of the source and the target scale, semantic equivalence and translation invariance. First, 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, Behling & Law, 2000; Marin & Marin, 1991; Beck, Bernal, & Froman, 2003). Second, translation invariance is gained by ensuring that the source and target scales measure the attributes of interest using psychometric tests. Semantic equivalence deals with the development of the instrument. Translation invariance is an assessment of how well the instrument performs when it is used in the intended group.

Semantic equivalence. The semantic equivalence addresses both the denotative and the connotative meanings (Villagran & Lucke, 2005). 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). There are five common methods for translating a scale or an instrument: one-way translation, back-translation, the committee approach with decentering, expert evaluation, and the use of a bilingual sample (Villagran & Lucke, 2005).

a. The *one-way translation* refers to the practice where one bilingual person translates the instrument from the original language to the language of the new version (Behling & Law, 2000; Marin & Marin, 1991). The quality of the translation is influenced by the skills and cultural background of the translator, as well as her interpretation of the items. According to Marin and Marin (1991), instruments translated this way do not meet the requirements for semantic equivalence.

b. *Back-translation* is probably the most common method (Behling & Law, 2000; Brislin, 1970, 1986). 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 or alternative translations to resolve disagreements. This process is repeated until translators agree. This method is generally accepted in cross-cultural research (Villagran & Lucke, 2005). Since the translators' background plays an important role, Marin and Marin (1991) recommend that when researchers describe the procedures of their studies, they include a description of the translators´ socioeconomic, cultural, and educational backgrounds, so the semantic equivalence of the translation can be better evaluated.

c. *The committee approach with decentering* describes a process where a team simultaneously compares two versions of an instrument and might modify either one of them to gain the same semantic meanings (Behling & Law, 2000). Consequently, the difference between them becomes irrelevant. This is not a useful method with the translation of an existing scale, because the process could very possibly change the source instrument's validity and reliability (Villagran & Lucke, 2005).

d. *Expert evaluation* refers to language experts that include people from various backgrounds (Villagran & Lucke, 2005). They evaluate the instrument as the researcher asks them to describe the connotative meaning of words and items. The existence of cultural or regional differences with connotations can be taken into account and corrected as problems are revealed through these meetings. This can be followed by psychometric tests such as comparisons of reliability, internal consistency, and factor structures between the two scales.

e. The final method entails that a *bilingual sample* completes both language versions and subsequently, their responses to the items are compared (Villagran & Lucke, 2005). Their answers are expected to be the same regardless of the language of the version. If the results are not the same, it suggests that something in the translation process is questionable. The validity of the responses is increased even more if the participants in the sample have lived in the culture of the second language long enough to be quite familiar with or knowledgeable about that culture.

Translation invariance. The second criteria suggested by Villagran and Lucke (2005) is to assess the translation invariance. 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). According to Villagran and Lucke (2005), "the observed response is a linear function of (1) the attribute or attributes being measured (factors), (2) the ability of each item to discriminate different quantities of the attribute (factor loadings), (3) the average response to each item at a fixed amount of the attribute (factor intercepts), and (4) the response variability associated with each item (item error or uniqueness)" (p. 249). There are four quality levels of assessment: configural variance, weak translation variance, strong translation variance, and strict translation variance (Villagran & Lucke, 2005).

The first and lowest level is *configural variance*. When confirmatory factor analysis is performed separately on both the original and the translated instruments, the results should reveal the same factor configuration. This means that it should show both the same number of factors and the same pattern of factor loadings (Villagran & Lucke, 2005).

Weak translation variance refers to a stage where both the translated version and the original version discriminate the attributes equally well indicating a model-fit (Villagran & Lucke, 2005). Factors loadings are constrained on both instruments to be equal. If an item discriminates the attribute differently between the two versions, the model does not fit and the problem needs to be resolved.

Strong translation invariance is a step higher, it assumes like the former stage that the factor loadings on each version are similar, but in addition, that "participants with the same attribute yield the same observed score" (p. 250), or the two versions are measuring the same attributes. It is tested "in modern factor analysis by constraining factor intercepts to equality between the two versions" (Villagran & Lucke, 2005, p. 250). If the model fits, one can assume that the same attributes are being measured.

Strict translation invariance has to do with the reliabilities of the two versions of the instrument, the original one and the translation. It not only assumes strong invariance, that the two versions are measuring the same attributes, they also require that they are measuring them equally well. This is measured by "indirectly constraining the reliabilities to be equal in the two versions" (Villagran & Lucke, 2005, p. 250).

Student Motivation

The MUSIC[SM] Model of Academic Motivation Inventory (MMAMI) that I translated for validation is based on the MUSIC[SM] Model of Academic Motivation (Jones, 2009; referred to in

this document as the "MUSIC model"). In this section, I examine each component of the MUSIC model and relate them to relevant motivation theories and supportive evidence from the science classroom.

The MUSIC℠ Model of Academic Motivation

The MUSIC model (Jones, 2009) includes current conceptions of motivation that have been shown critical to students' motivation and engagement in the classroom (Deci & Ryan, 1991, 2002; Jones, 2009; Wigfield & Eccles, 2000). The five key components in the model are e**M**powerment, **U**sefulness, **S**uccess, **I**nterest, and **C**aring (MUSIC) and the definitions for each from Jones (2015) are provided in Table 1.

Table 1.
The MMAMI Constructs and Their Definitions

MUSIC model constructs	Definitions The degree to which a student perceives that:	Related constructs
Empower-ment	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 coursework	Expectancy for success (Wigfield & Eccles, 2000)
Interest	the instructional methods and coursework are interesting	Situational interest (Hidi & Renninger, 2006)
Caring	the instructor cares about whether the student succeeds in the coursework and cares about the student's well-being	Caring (Noddings, 1992)

Empowerment. *Empowerment* refers to "the amount of perceived control that students have over their learning" (Jones, 2009, p. 273). Deci and Ryan (self-determination theory; 2000; 2002) found that autonomy is an important component to student motivation. When students perceive that they have some choices within a task structure, their *locus of control* is likely to be more internal (Deci & Ryan, 2000). They do not feel controlled, they believe that they can influence events and their outcomes, and they experience an ownership of the results of their work. This increases motivation and encourages self-regulation. Students learn to organize themselves, make decisions, and meet deadlines. When students feel that their voice is heard, or that their opinions matter, they perceive autonomy (Liu, Hsiek, Cho, & Schallert, 2006; Logan & Skamp, 2008). They feel respected and valued (Logan & Skamp, 2008). An instructional context that involves challenges, autonomy and choices has been shown to positively influence motivation (Deci & Ryan, 1985; Hidi & Harackiewicz, 2000), student engagement and achievement (de Charms, 1976; Deci & Ryan, 2000; McCombs, 1991, 1993, 1994a, 1994b). An autonomy-supportive teacher has rules and limits, but his or her methods are non-controlling and informational (Reeve, 2006). "Students of autonomy-supportive teachers have been shown to receive many benefits, including enhanced conceptual learning, greater perceived academic and social competence, a higher sense of self-worth and self-esteem, greater creativity, a preference for challenging tasks, a more positive emotional tone, increased school attendance, and higher grades" (Jones, 2009, p. 274).

In a mixed methods study with 437 sixth-grade students, students indicated that their increased self-efficacy for science stemmed from feeling autonomous, feeling like a scientist, and from being equipped with the tools to research information and subsequently solve problems (Liu, 2005). The increased self-efficacy that students experienced was a significant predictor of

achievement (Liu et al., 2006). Students' increased knowledge on the topic was significantly related to their increased positive attitude towards science, expressed with increased motivation and engagement (Liu, 2005).

Usefulness. The concept of *usefulness* refers to students' perceptions of how a learning activity can be useful to them, presently or in the future (Jones, 2009). Believing in the usefulness of one's endevours increases motivation and engagement in the activity (De Volder & Lens, 1982; Wigfield & Eccles, 2000), especially if the effort is perceived to be beneficial for long-term goals (Simons, Vansteenkiste, Lens, & Lacante, 2004; Van Calster, Lens, & Nuttin, 1987). Even if students are not motivated to perform a task for its own sake, it can be valuable to them if it facilitates some important goals.

A study of boys in 11th grade (Nieswandt & Shanahan, 2008) indicated that their initial motivation to study the course material was directed towards meeting an administrative requirement, described by the phrase, "just need a credit." But there was a change in the boys' "motivational structure towards more intrinsic orientations when they were engaged in topics with personal everyday and future relevance" (Nieswandt & Shanahan, 2008, p. 3). Similarly, Jocz, Zhai, and Tan (2014) found that peer discussion of real-life application of science had a stronger relationship to students' interest than hands-on activities that were, however, also considered fun and interesting.

Wigfield and Eccles (expectancy-value theory; 2000) use the term *utility value* where the value is determined by how well the task relates to current or future goals. A study investigating urban seventh grade students' perception of the utility value of their guided biology inquiry revealed high value ratings and the greatest interest in the investigation tasks (Sandoval &

Harven, 2011). A task that is perceived as useful increases motivation and engagement (Wigfield & Eccles, 2000).

Success. 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 key for 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. 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; Bandura, Barbaranelli, Caprara, & Pastorelli, 2001). If we perceive that we can be successful, that is, we have self-efficacy for the task, we are more likely to be motivated to perform the task (Wigfield & Eccles, 2000; expectancy-value theory).

Self-efficacy, which like self-concept is multidimensional (Bandura, 1997; Marsh, 1990), influences motivation and performance (Bandura, 1997; Bandura et al., 2001; Bong & Skaalvik, 2003). When we are successful our self-efficacy increases (Bandura, 1997). Marsh and O'Mara (2008) asserted that there are reciprocal effects between the academic self-concept, general self-esteem, and achievement/perceived success.

Strong self-efficacy for a subject develops very early as children perform their tasks and deal with various challenges in their lives (Bandura, 1997; Björnsdóttir et al., 2008; Freudenthaler, Spinath, & Neubauer, 2008; Wigfield et al., 1997). Even as early as in the elementary grades, many children have developed beliefs about their competence in certain domains as well as determined the value of subjects, and there is a moderate to strong stability in these beliefs (Dermitzaki, Leondari, & Goudas, 2009; Wigfield et al., 1997). Ability-beliefs and

expectancy-beliefs are not empirically distinguishable and consistently load together in statistical analysis (Eccles et al., 1993). Consequently, it is very important that the challenges students encounter in the early school years result mostly in success (James, 1892/1968). Ensuring success will promote the development of a healthy individual with strong self-efficacy. If failure becomes the norm, a child is likely to turn away from that academic subject and seek another way to boost up "the self" (James, 1892/1968; Steele, 1988).

Teaching strategies seem to play a role in students' feelings of success as well as in students' perceptions of empowerment and usefulness, the MUSIC components discussed earlier. Some student-centered teaching strategies, such as Inquiry or Problem-Based-Learning (PBL), possess elements that promote empowerment and the perception of usefulness. Learning projects often relate to real life situations, such as oil leaks or pollution, so students perceive the usefulness of their studies. Frequently, they also provide a step-for-step guidance that increases students' perceptions of success (Sandoval & Harven, 2011) and enough autonomy for students to own their success. As a result self-efficacy increases (Deci & Ryan, 1985, 2000).

Several studies have reported significant science achievement gains in the middle and secondary school inquiry classroom (Annetta, Mangrum, Holmes, Callazo, & Cheng, 2009; Jang, 2006; Liu, 2005; Liu et al., 2006; Liu, Horton, Olmanson, & Toprac, 2011; Mehalik, Doppelt, & Schunn, 2008). In their study, for example, Liu et al. (2006) and Liu (2005) described how students' self-efficacy increased during the inquiry learning and self-efficacy was a significant predictor of science achievement. When students felt successful, their self-efficacy for the task increased and they achieved. Not only did students believe that they were successful, but they actually succeeded, based on assessment. Retention was superior and high science knowledge scores were related to a positive attitude towards science and goal orientation (Liu, 2005).

Comparing an inquiry classroom to a traditional control group, Hand, Wallace and Yang (2004) found that students' achievement was better in the inquiry classroom and their questions on a higher cognitive level than in the control group. Similarly, Geier et al. (2008) reported an increase in science content understanding and significantly higher pass rates on statewide tests for the inquiry group students.

Interest. Interest is a construct that needs some clarification because of its frequent and complex use in the research literature (Schunk et al., 2008). In this paper, the construct interest will be used in a manner consistent with Schraw and Lehman (2001, p. 23), defined as a "…liking and willful engagement in an activity." The *liking* refers to positive emotions. As such, being interested is an affective state leading to an action (Jones, 2009). *Willful engagement* describes a cognitive state where one is consciously concentrating or paying attention to a subject or activity (Hidi & Renninger, 2006). Schunk et al. (2008) describe interest as one of the influential factors in increasing motivation. 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). It plays an important role in the learning process by directing students' attention and determining what they learn. It affects their cognitive, emotional and behavioral engagement, and increases and deepens their learning.

Theorists classify interest as a content specific phenomenon that is created in the individual through a reaction to the environment (Hidi & Harackiewicz, 2000). They have divided interest into *individual interest* that is a stable orientation, and *situational interest* that is more reactive, context-dependent, and temporary (see also personal interest; Urdan & Turner, 2005).

Situational interest is an affect and can be described as a certain type of curiosity, or giving a special attention to a topic. Ainley and Ainley (2011) reported that "enjoyment is central to relations between interest in science, value and knowledge, and students' reported current and future engagement" (p. 4). Social interaction, suspense, controversy, games, novelty, humor, or situations that engender emotions have been found to increase situational interest and subsequently motivation and engagement (Bergin, 1999). These factors serve to attract students' attention, a condition that is fundamental for deep and meaningful learning (Hidi & Renninger, 2006).

Acquiring some perceivably valuable knowledge in a subject in an interesting context may lead the student to gradually develop an *individual interest* (Hidi & Renninger, 2006; Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000). A student, whose individual interest might be emerging, generates her own questions and seeks out opportunities to do some independent studying or research on a topic. Many children develop an individual or a personal interest in a task at a young age; these children pay closer attention, persist and learn more than those who are less interested (Ainley, 1994; Renninger, 1998; Schiefele, 1991). The interests that develop during the middle schools years and even earlier have been found to be strong and stable, and also very influential for attention span, memory, and recognition (Renninger & Wozniak, 1985). Situational interest does not necessarily develop into an individual interest. Instructors cannot ensure the development of students' individual interests, but as Hidi (1990) argues, using situational interest in the classroom can significantly influence unmotivated children and encourage their involvement in certain subjects. It is important to note that situational and individual interests are not dichotomous phenomena but can interact and influence each other (Hidi, 1990).

Several studies have linked situational interest in the student-centered, middle school, science classroom to motivation and engagement (Doppelt, Mehalik, Schunn, Silk, & Krysinski, 2008; Doppelt & Schunn, 2008; Liu, 2005; Logan & Skamp, 2008). In their study, Guvercin, Tekkaya, and Sungur (2010) reported that students maintained their interest throughout the session, and that students indicated that the teacher's pedagogical approach and the classroom environment (situational interest) were the most important factors for their motivation. Another study similarly noted that the teacher's pedagogical approach influenced students' engagement positively (Logan and Skamp, 2008). Doppelt and Schunn (2008) found that students showed increased interest, success and desire to learn, and their interest in taking science classes in high school was significantly higher after participating in an inquiry classroom where situational interest was triggered in several ways. In another student-centered study, seventh grade students expressed a great interest in a biology inquiry/investigation (Sandoval & Harven, 2011).

Caring. A caring classroom environment promotes motivation, learning, and general well-being (Bandura, 1997). 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 can probably only develop when people get to know each other, when they establish relatedness. They suggested that there are three processes necessary to establish relatedness: a sense of belonging, reciprocity, and mutuality. A sense of belonging is established when people feel that they are needed, highly valued, and important in a relationship, or they experience "a fit" within a group. Reciprocity refers to the process of giving and taking in a relationship, creating a balance. Mutuality refers to real or perceived shared commonalities, and acceptance of differences in the relationship, whether it is in a group or between individuals.

Deci and Ryan (self-determination theory; 1985), similarly, 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, academically or personally, are generally more motivated (Jones, 2009). The relationship that students have with the teacher similarly affects their attitude toward the subject taught (Davis, Davis, Smith, & Capa, 2003). Several reports have indicated that when students have a good relationship with their teacher, they perceive their work as meaningful and fun and are consequently, more motivated (Davis et al., 2003; Davis, Schutz, Chambliss, & Couch, 2001). 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, 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.

Interestingly, middle school students' prior experiences with teachers (in elementary school) seem to be influential for their current motivation (Davis, 2006). Students who have had a good experience with prior teachers in elementary school express a stronger motivation, receive higher scores for academic social skills from their teachers and claim to have a positive view of the new teacher relationship as they start middle school.

Students need a lot of guidance and support going through the adolescence years of biological, cognitive and relational changes (Eccles, Wigfield & Schiefele, 1998; Wigfield & Eccles, 2002). In comparison with the elementary school, middle schools are usually characterized by more teacher control and discipline, and as such can create a feeling of a lack of autonomy, success, and caring (Wigfield & Eccles, 2002). In fact, middle school students report

feeling less autonomous and less competent in the classroom than their elementary counterparts. In addition, their grades tend to drop, partly because they find the instruction in middle school less personal and feel less encouraged by their teachers (Wigfield & Eccles, 2002). Middle school students vary considerably in their cognitive development. Their abilities for higher cognitive functions, such as critical thinking and reasoning skills are still developing (Wigfield & Eccles, 2002). This can influence their adjustment to this educational level, not the least through their feelings of self-efficacy.

According to Harter (1986), children's opinions of their physical appearance and social acceptance have the strongest relationship to children's overall feelings of self-worth in both elementary school children and among adolescents. Students are often searching for their own identity, in other words, trying to figure out "who they are" (Erikson, 1963; Wigfield & Eccles, 2002). Every child wants to be accepted by others, especially their peers. Peers are playing a more significant role for children at this age than they did before. Peer relationships promote personal and social development, as friendships develop (Ormrod, 2009). Friends, for example, teach each other appropriate behavior (Erwin, 1993; Ginsberg, Gottman & Parker, 1986) and having friends provides one with support and safety (Berndt, 2002; Doll, Song, & Siemers, 2004). Adolescents generally rely more on their peers than adults for emotional support when they are confused or hurting (Juvonen, 2006). Children who feel that they do not get approval for being themselves (true self), that is, they feel devalued in some ways, rate the lowest on self-esteem levels (Harter, Waters, & Whitesell, 1997). Research shows that children's self-esteem is the lowest, right after they transition from elementary to middle school (often in 7th grade) but increases again as they adjust to the new environment. Lack of self-efficacy reduces motivation

and engagement (Eccles et al., 1998). Consequently, the classroom environment is of great importance to children's well-being and learning.

Deci and Ryan (2000) encourage instructors to foster interpersonal, caring relationships between themselves and their students, and between students. Good relationships and peer networks increase academic motivation and general well-being (Deci & Ryan, 2000; Schunk et al., 2008), as well as academic performance (Schunk et al., 2008). Middle school is a critical time for the fostering of good relationships as children's connection to peer groups increases (Eccles & Midgley, 1989). Students have an increased need for social contact with their peers and generally enjoy social interaction (Ormrod, 2009). Instructors might help meet this need by fostering a friendly and supportive cooperative environment in the classroom, an environment that encourages personal relations (Eccles & Midgley, 1989). When the teacher works as a facilitator in a cooperative setting, not only does she get to know her students better, but she also has a much better opportunity to encourage students and guide the social interaction in the classroom. Encouragement increases self-efficacy that contributes to success. According to Dewey (1944) and Vygotsky (1978), the quality of students' social interaction plays a key role in the development of the self, self-efficacy, and learning.

Teaching Strategies and Motivation

Many motivation researchers and educators have examined the reasons for students' lack of motivation. Some have blamed it on increased academic demands, lack of adequate student preparation in previous institutions, a student population with different values, or lack of preparation in the teacher education curriculum, both in terms of teaching strategies, and practical knowledge (NRC, 2009). This has set in motion a wave of discussion and research on the characteristics of the various teaching methods and the motivating factors that they possess.

Traditionally, the science classroom has been teacher-centered where the teacher transmits information to students sitting at desks that are usually arranged in rows, and instruction mostly guided by chapters in textbooks (Cuban, 1982, 1993; Wigfield & Eccles, 2002). Students generally work individually (Kim, 2005), copying notes from a blackboard or slides, answering questions in workbooks, or filling in the blanks on worksheets (Cuban, 1982). In order to fulfill the requirements, students memorize the content of the textbooks and take exams so their knowledge acquisition can be measured. In addition, teachers control lab sessions by composing the questions, directing the process, and discussing the "right results," without much input from students (Wigfield & Eccles, 2002). Teachers´ thinking guides the process. These teacher-centered instructional strategies have been criticized at least for the last five decades (Cuban, 1993) and are frequently blamed for students' lack of motivation (Cuban, 1993, Ormrod, 2009). The teacher-centered classroom environment has been found lacking in regards to several motivation components (Kember & Gow, 1994). Educational psychologists debate how deep and meaningful this traditional type of learning experience is, and wonder if students can apply the acquired knowledge to the real world (Ormrod, 2009). The amount and quality of learning that takes place under these circumstances depend on various factors, such as students' background, cognitive development, and prior knowledge.

Development in science education. In the National Science Education Standards (NSES, 1996; NRC, 1996), the importance of inquiry strategies in a cooperative environment was stressed. The council's objectives were to increase student motivation so students would acquire practical knowledge for life, and to increase interest so more students would study science and eventually, enter the profession. The National Science Education Standards (1996) defined inquiry as "a multifaceted activity that involves making observations; posing questions; planning

investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results" (NRC, 1996, p. 23). It is a student-centered strategy because students work on problem solving in small groups, self-directed to a certain degree, with instructors acting as facilitators (Hmelo-Silver, 2004). Furtak, Seidel, Iverson, and Briggs (2012) suggest that inquiry should be understood as existing on a spectrum because of the different levels of facilitator input and the variety of activities and thinking processes in which students are involved. It is by many theorists regarded as an umbrella concept covering various learner-centered strategies, such as Design Based Learning (DBL), Problem Based Learning (PBL), and Constructivist learning strategies (Hmelo-Silver, Duncan, & Chinn, 2007).

Inquiry strategies did not spread widely in the middle school classroom following the 1996 NSES in the US (Wigfield & Eccles, 2002), even though they became more common (Hmelo-Silver et al., 2007). The decision of how to respond to these new standards was primarily in the hands of the schools. Some schools continued using the older teaching strategies, while other schools instigated more cooperatively based lab experiences (Bonnstetter, 1998). Often, the new strategies were however too scripted and could hardly be classified as inquiry.

Motivation remained low in science classes (NRC, 2007). Students still lacked interest in science as indicated by a declining number of students choosing science courses in high school (Cleaves, 2005, NRC, 2012), degree programs in college and careers in science (NRC, 2009), and attrition in science classes at the university level stayed high (National Center for Education Statistics, [NCES], 2013).

More recently, the Next Generation Science Standards (NGSS, 2013; NRC, 2012) were developed, based on the 2011 NRC Report, *A Framework for K-12 Science Education:*

Practices, Crosscutting Concepts, and Core Ideas (NRC, 2012). The new standards are expected to prepare students better than the older ones for an intensive science study, as well as to motivate and inspire students (NRC, 2012). They claim that it is important for students to explore the practical use of science by focusing on a limited number of fundamental ideas that support the unification of science and engineering. Students need to connect prior knowledge with the practices of scientific inquiry and engineering design. The new K-12 framework is expected to strongly influence instructional methods, assessment, and professional development. Research-based evidence for improving science teaching and learning is provided (NRC, 2012).

Inquiry and motivation factors. There has been a development towards more student-centered classroom strategies in many subjects and studies conducted to measure student motivation, especially in higher education (Hmelo-Silver, 2004). Research in the middle school inquiry classroom, employing large sample sizes, and research comparing motivation levels in the teacher-centered classroom to motivation levels in the student-centered classroom is still limited but gradually increasing (Hmelo-Silver, 2004). Some researchers have, nevertheless, found several motivation factors in the inquiry classroom in compulsory schools, as mentioned earlier. Students have reported feeling *empowered* (Hmelo-Silver, 2004; Liu et al., 2006; Logan & Skamp, 2008). It increases motivation and encourages self-regulation when students perceive that they have some control over their own studies (Jones, 2009). Students who are cooperatively seeking a solution to socio-scientific issues or real-life situations report that they perceive their studies as *useful* or valuable and that their motivation generally increases (Bonnstetter, 1998; Sandoval & Harven, 2011). Furthermore, since the focus in the student-centered classroom is on the individual and his needs, students have the support and the tools they need to complete the activities and they report increased self-efficacy and *success* (Doppelt et al., 2008; Hmelo-Silver,

2004; Liu et al., 2006). This success positively influences motivation and performance (Bong & Skaalvik, 2003). Children tend to be interested in subjects in which they feel successful (Wigfield and Eccles, 2000). Situational *interest* is triggered through the facilitators' use of real-life stories, hands-on projects and cooperative learning (Doppelt & Schunn, 2008; Doppelt et al., 2008; Logan & Skamp, 2008), increasing engagement (Doppelt et al., 2008). Finally, in the student-centered classroom, instructors or facilitators may have a better chance of getting to know students and their story. This could give them a better chance of developing closer relationships with their students, so students feel *cared for* academically or personally. Instructors can also promote a good social environment so a sense of belonging can be established among students. Caring is an important component for motivation and the inquiry classroom is a good field for developing caring (Wolf & Fraser, 2008).

Summary

In this literature review, I have discussed the factors that play a role in middle school student motivation within the framework of the MUSIC model (Jones, 2009). Many educators are concerned with finding ways to meet students' needs at this age level, so that the decline in students' motivation can be lessened and their academic performance enhanced (Hidi & Harackiewicz, 2000). As I saw the MMAMI as a helpful tool for middle school teachers to realize what factors motivated their students, I examined guidelines given in the literature for the translation and validation of instruments from one language and culture to another, to aid in the translation of the MMAMI-English to MMAMI-Icelandic. In the next chapter, I will describe the methodology for this translation process.

Chapter 3: Methodology

The purpose of this study is to examine the extent to which an Icelandic version of the MUSIC[SM] Model of Academic Motivation Inventory (MMAMI-Icelandic) produced valid scores for Icelandic middle school students in science classes. With the permission of the Virginia Tech Institutional Review Board (IRB) and the Icelandic Institutional Review Board (Persónuvernd), I collected data during Spring 2014 and Spring 2015 from fifth to eighth grade students in five Icelandic compulsory schools. School administrators, teachers, and parents of participants gave their consent, as well as the participating students. Students completed an inventory that included the 18 items on the MMAMI-Icelandic.

First Data Collection

Participants

For the first data collection in Spring 2014, participants were 207 sixth- to eighth-grade students in two Icelandic, public schools. The sample was a convenience sample, where the participating schools were recruited through social networking media. Both schools were located in or near the capital, Reykjavik. 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 Ministry of Education science standards. In one school, the three participating sixth-grade science teachers (who were all females) were also the students' classroom teachers. The school's main science teacher (a male) taught the four seventh-grade and three eighth-grade classes. In the other school, the science teacher, also a male, taught the combined group of sixth

and seventh graders, as well as the eighth grade science class. The classes included students with various special needs who in some cases had an assistant teacher to accompany them. All teachers had many years of experience teaching with the exception of one teacher who had only taught for one year.

Instruments

The MUSIC^{SM} Model of Academic Motivation Inventory (MMAMI). The purpose of the study was to translate the MMAMI from English into Icelandic and validate it for use with Icelandic middle school students in science. Jones (2012) developed the college student version of the MMAMI, which is 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 with empirical evidence through a series of reviews, revisions, and testing with undergraduate college students (Jones & Skaggs, in press). The results from the item analysis on each subscale and the total instrument indicated alpha coefficients ranging from .93 to .96 for the subscales indicating strong internal consistency reliability, and convergent/divergent validity of the subscales. The items exhibited good statistical properties individually, including means, standard deviations, and positive discriminations. Response variance was considerable and most item/scale correlations exceeded .70, with no correlations under .50. Convergent and divergent validity evidence for the subscales was evidenced further by the fact that the MMAMI subscales were correlated with instruments that measured similar constructs (Jones & Skaggs, in press).

Because the MMAMI items were of a high caliber, it was possible to shorten the subscales to create a middle school version without losing much internal consistency reliability. The shorter 18-item version of the MMAMI (Jones, 2012; see Appendix A) was tested

empirically and shown to be acceptable for use with U.S. middle school students in science (Jones & Wilkins, 2013b, 2015). As hypothesized, validity evidence indicated that the five factors were somewhat correlated, yet distinct (Jones & Wilkins, 2013b, 2015). The subscales for the shorter 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. The subscales in the inventory have been shown to adequately represent the five components of the MUSIC model with fifth, sixth, and seventh grade students (Jones & Wilkins, 2013b, 2015).

Translation procedures for the MMAMI-Icelandic. The Icelandic version is a translation of the 18-item English, middle school version of the MMAMI. The MMAMI-Icelandic similarly consists of five subscales, one for each component of the MUSIC model. I divided the translation procedures into two sections, first the translation/back-translation for semantic equivalence, and subsequently the completion of psychometric tests to assess translation invariance.

For the process of gaining semantic equivalence between the original version and the translation, both denotative and connotative, I chose to use back-translation, followed by evaluative, expert meetings to resolve differences (Behling & Law, 2000; Brislin, 1970, 1986). This is the most common way to translate an instrument and considered an acceptable method (Villagran & Lucke, 2005). Because of the importance of this process, the translators had to be carefully selected.

As emphasized in the *Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 1999), it is important to describe the qualifications and experiences of

participating experts and judges. The translation team consisted of three people. As the principal investigator, I performed the initial translation. I am a native Icelander, but I have spent several years of my life in the US, as my husband is American, and most of my university education has taken place in the US. Thus, I am very familiar with both cultures and bilingual. Having translated the MMAMI from English to Icelandic, I gave the Icelandic version to a 32-year-old woman who had studied translation sciences during her Masters studies in English at the University of Iceland. She was brought up in a bilingual home and has lived in both countries for extended periods of her life. She translated the Icelandic version back into English without viewing the original version (back-translation). Then we compared her English translation to the original version of the MMAMI with a third bilingual expert who was also brought up with parents of both nationalities and has a Bachelor's degree in the English language and culture. She was 28 years old and had also lived in the US for a period of her childhood. In this expert meeting, we discussed the denotative and connotative meaning of the words, the items where the back-translation was different, and then came to a joint conclusion or an agreement about the final version of the translation. Back-translation with a subsequent evaluative meeting to discuss differences between versions provides a solid foundation for the semantic equivalence.

Of the 18 items in the MMAMI-Icelandic, 12 items were translated back to English with almost the exact wording that the original version used (for the original and translated inventories, see Appendices A and B). Thus, these items passed without much discussion. Below are examples of items that were discussed. The original version is listed first, then the Icelandic translation, followed by the back-translation in the third line:

eMpowerment:

Example 1:

Original: I have options in how to achieve the goals in science class (M3).

Icelandic: Ég hef ýmsa möguleika á því hvernig ég næ markmiðum í náttúrufræðitímum.

Back-translation: I have different options to choose from in order to reach the goals in science class.

We agreed that the original translation and the back-translation were similar enough. We wondered if the Icelandic translation would be too formal for students, especially the word for goal, *markmið*, but we decided to keep the translation as it captured the original, English version very well.

Example 2:

Original: I have control over how I learn the content in science class (M4).

Icelandic: Ég ræð því hvernig ég læri námsefnið í náttúrufræðitímum.

Back-translation: It is up to me how I study the course work in science class.

We agreed that " learn" is a closer translation to the Icelandic word "læri" than "study." We added "og vinn með" which means "and work with" to make sure the item included a wide variety of study activities in the lesson.

Final version: Ég ræð því hvernig ég vinn með eða læri námsefnið í náttúrufræðitímum.

Usefulness:

Original: I find science class work to be *relevant* to my future (italics added here for emphasis; U3).

Icelandic: Mér finnst vinnan í náttúrufræðinni vera *þýðingarmikil* fyrir framtíðina.

Back-translation: I think that the work I do in science is *important* for my future (italics added here for emphasis).

We agreed that *relevant* captured the meaning for „þýðingarmikill“ better than the word important, supporting the translation.

Success:

Original: I feel that I can be successful in meeting the academic challenges in science class (S3).

Icelandic: Mér finnst að ég geti mætt námskröfunum í náttúrufræðinni.

Back- translation: I feel that I can fulfill the educational requirements in the science course.

We were not sure if all students would understand the Icelandic words for educational requirements or academic challenges. After a long discussion this translation was simplified to adapt it better to middle school students.

Final version: Mér finnst ég geti skilað því af mér sem ætlast er til af mér í náttúrufræðinni (Engl: …completed what was expected of me).

Interest:

Original: The science class work *holds* my attention.

Icelandic: Vinnan í náttúrufræðitímunum heldur athygli minni.

Back-translation: The work I do in science class *captivates* my attention.

We agreed that the original term *holds* fits better than *captivates* for the Icelandic term.

All the caring items were accepted without any further discussion. The back-translation for two of the items used exactly the same words and word order. The three experts agreed that the denotative and connotative meaning of the items in the instruments were the same in both language versions.

Data Collection

A female teaching assistant and I collected the data. At the end of each lesson, participants completed the translated MMAMI-Icelandic, a task that took 10-15 minutes to complete. Except for the sixth graders who completed it in their home classroom, the participants were in the science lab room. As I administered the inventory, I explained that students were not obliged to complete the questionnaire but their collaboration would be very much appreciated. I told them that I was interested in their honest opinions and that their valuable information would only be used for my research purposes. The assistant provided extra help to a few students who had difficulties reading or understanding the items.

In the first data collection, the focus of the data collection was on the lesson that students had just finished. A class period lasted generally 40 minutes, but lab or experiment sessions usually lasted 80 minutes. The questionnaire was given in the end of that lesson, so the tense was changed to the past, and the reference to science classes in general was changed to refer to the class or the science lesson that the student had just finished. One of the 18 items from the MMAMI-Icelandic was not used in the first data collection because, at the time, the initial purpose of the data collection was slightly different and did not require that item. This item was added in the revised version for the second data collection.

Data Analysis

To provide evidence of construct validity for the translated instrument, I performed an exploratory factor analysis (EFA) with the first sample. The purpose for the EFA was to identify specific items that might be problematic, or in general, to use the results to make a judgment on revising the first version of the instrument. Subsequently, I planned to collect another sample to perform a confirmatory factor analysis (CFA) with the purpose of testing the fit of the measurement model (Pedhazur & Schmelkin, 1991). This is a standard practice in instrument

development. As recommended by both Costello and Osborne (2005), and Pedhazur and Schmelkin (1991), I conducted the EFA using Principal Axis Factoring (*PAF*) with Promax Rotation and Kaiser Normalization. PAF is considered a superior factor extraction method. 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 and Strahan, 1999). PAF estimates the level of shared variance (communalities) for the items so factor loadings are more accurate. I 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).

There are various *rules of thumb* regarding sample size, suggesting from 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. Since the first data collection is used primarily as a preliminary test to perform an EFA with the goal of revising faulty items, the ratio of 12/1 is acceptable.

Second Data Collection

Participants

Students from three Icelandic, public schools participated in the second data collection. Two of the schools were in the capital, Reykjavik, and one was in a more rural area, a small town. These three schools were not the same ones reported in the first data collection. The sample was a convenience sample as the first sample. Participants were 241 fifth to eight grade students. 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. Around half of the students were female and half male. Most of the students, 209 (87%), had Icelandic parents, 14 (almost 6%) had foreign parents, 15 (6%) had a foreign mother, and 3 (1%) had a foreign father. The focus of the coursework was in accordance with the mandated science curriculum.

Revisions to the MMAMI-Icelandic

If needed, I planned to make revisions to the MMAMI-Icelandic based on the results of the factor loadings in the EFA. If all of the items loaded adequately with the other items in their subscales, there would be no need to revise items, I would simply conduct the second data collection. However, if the loadings for some items were inadequate, I planned to examine the wording of the items and make revisions as necessary on an item-by-item basis. Tabachnick and Fidell (1996) propose that loadings greater than .32 are adequate in sociobehavioral research, meaning that the item equates to about 10% of the overlapping variance with the other items in that factor. However, my goal was to reach loadings of .50 or better which Costello and Osborne (2005) suggest is "desirable and indicate a solid factor" (p. 5). Consequently, a few items were revised. In this second data collection, the revised instrument was used (see Appendix B).

Data Collection

At the end of a science class, the teacher read the directions for the MMAMI-Icelandic that I had provided and then handed out the inventory to all students participating in the class. Students had about 10-15 minutes, ample time, to complete the 18 items. Students placed their completed inventory in an envelope as they walked out of the classroom. The forms had no names, but gender, age group (fifth grade, sixth, etc.) and origin of parents were items for which students were asked to provide information. The focus for the items on the questionnaire was on the ongoing science classes that year; thus, the present tense was used.

Data Analysis

The goal of the data analysis was to validate the translated instrument for use with similar groups of students. It is important to note that when one talks about validating an instrument, one is not really validating the instrument itself but rather the inferences that are made based on the scores from the instrument, or the interpretation of the scores (AERA, APA & NCME, 1999; Pedhazur & Schmelkin, 1991). I discuss three sources of validity for these inferences. I did not include content validity as validity evidence in the table (see Table 2). Content refers to a domain of some content, in this case motivation research. Pedhazur and Schmelkin (1991) claim that albeit of great importance, the content of an instrument is irrelevant to validity because validity refers to inferences made about scores, as mentioned earlier, but is not an evaluation of the content of an instrument. The content of the MMAMI is research based. In general, it is not possible in a sociobehavioral study to know all the factors that are associated with a construct such as motivation. However, I would like to emphasize that the MMAMI has been shown to represent motivation, as it is defined in this study, through the examination of experts (Jones, 2012; Jones & Skaggs, in press). The items derive from the MUSIC Model of Academic Motivation (Jones, 2009), a model that is based on integrated, existing research and theories of students' academic motivation. This research cites ample examples of how the five MUSIC constructs are related to academic motivation (e.g., Bergin & Bergin, 2009; Hidi & Renninger, 2006; Marsh, 1990; Ryan & Deci, 2000; Wigfield & Eccles, 2000). The translated instrument is based on the same research as underlies the model.

To determine the validity of the MMAMI-Icelandic or the inferences thereof, I examined three types of validity evidence: internal consistency reliability, construct validity, and

discriminant/convergent validity, a subgroup of construct validity. Table 2 shows the sources that I used to examine the different types of validity.

Table 2.
Sources of Validity Evidence

Validity Evidence	Sources
Internal consistency reliability (item analysis)	• Cronbach‘s alpha values for the MUSIC Inventory subscales in the second data collection.
Construct validity (Discriminant/convergent validity)	• Exploratory factor analysis of the items from the first data collection. • Confirmatory factor analysis of the items from the second data collection. • Correlations among MUSIC Inventory subscales.

Internal consistency reliability. I examined the internal consistency reliability by computing Cronbachs’s alpha values for each MUSIC inventory subscale. Doing so allowed me to assess the extent to which items within any one subscale were correlated with one another (Howell, 2007). Subsequently, I compared my results to the results of the original English, middle school version. I 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, I used exploratory and confirmatory factor analysis (George & Mallery, 2003). It should be noted that, as Pedhazur and Schmelkin (1991) argue, the answer to the question whether the construct is valid should always take into consideration the definition used in the study. In other words, the question whether an instrument is measuring motivation “overlooks the fact that one is dealing with an abstraction, not with some object against which the measure can be applied in order to ascertain whether it ‘fits’” (p. 69). They suggest that a better question would be to ask whether it is consistent with the

definition of the construct it is supposed to be reflecting. In this study, motivation is defined as "the process whereby goal-directed activity is instigated and sustained" (Schunk et al., 2008, p. 4). As such, it is a process where individuals make choices about whether or not to act. This is the definition that underlies the MUSIC model and the items in the inventory.

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 inventory and the Icelandic translation are based on the MUSIC model as the conceptual context as it builds on theories and research on motivation (Jones, 2009). Researchers have performed factor analyses for the MMAMI-English demonstrating that the five constructs could clearly be perceived as statistically distinct (Jones & Skaggs, in press; Jones & Wilkins, 2013a, 2013b, 2015). I used EFA for the first data set to identify faulty items and revise the original version for use with the second sample. EFA is as the name indicates a method used for the purpose of exploring the data. It deals with how many factors are needed to explain the relationship among a set of indicators, using the factors loadings (Pedhazur & Schmelkin, 1991). I conducted a confirmatory factor analysis (*CFA*) on the second data set. *CFA* enables researchers to test hypotheses for factor structure and model-fit, using inferential techniques and also provides more informative analytic options. I 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/convergent validity. Discriminant/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. I assessed the validity by examining the correlations among the MMAMI subscales. When subscales are distinct, they are not highly correlated among themselves but discriminate; when they converge, they are correlated. Furthermore, the correlations of the items across subscales should be lower than the correlations of the items within the subscales (Thorndike, 1997).

Chapter 4: Results

In this chapter, I present the results of the first and second data collection. The purpose of the first data collection was to examine the construct validity of the items to determine whether or not the MMAMI-Icelandic was viable for use with middle school students in Iceland. The purpose of the second data collection was to examine the reliability and validity of the items to confirm the validity of the scores produced by the MMAMI-Icelandic through the collection of different data than was used in the first data collection.

Results of the First Data Collection

Construct Validity

I 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, 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 3. Overall, the results were quite good, as evidenced by several findings. First, all of the items except for one had the highest loading on the factor with the other items in the same subscale (denoted by the boldface numbers in Table 3). 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 (the factors on which the items did not load highest) were very low in most cases and 63 out of 68 of them (93%) were less than 0.2.

Table 3
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 the goal of reaching a factor loading closer to .50, I targeted four items for possible re-wording: M3, U1, S3, and C4. I met with the same group of translators to discuss these items for possible re-writing. Following this expert meeting, I discussed and tested the new items with four students on two different occasions, two students at a time. The students were in fifth to eighth grade. Some suggestions and thoughts from the students were discussed at a

second expert meeting, as the revision was completed. The results of the meetings are described in the following sections briefly. The completely revised MMAMI-Icelandic is in Appendix B.

M3 item. The M3 item did not load very highly with the other empowerment items (loading = .33). It was over the common cutoff of .32 (Tabachnick & Fidell, 1996), but I wondered if it could be reworded for better results. A factor loading closer to .50 was the goal. 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*. As it turned out, during the first data collection, many students asked for assistance with this item as they were filling out the questionnaire. They did not seem to understand the item very well. 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 and simplified 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 simplified and 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, which was acceptable. However, this item seemed to confuse some students as they were filling out the questionnaire, so they required assistance. It was also an item that had required the most discussion in the initial meeting with the translators. We decided to revise it. 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, which is under the minimum of .32 (Tabachnick & Fidell, 1996). 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, the translators, but we decided to simplify it in case students had not understood 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.

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 $\alpha = .68$; usefulness $\alpha = .87$; success $\alpha = .83$; interest $\alpha = .86$; caring $\alpha = .88$. For comparison with the internal consistency of the original version (Jones & Wilkins, 2013b), see 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 that obtained with the original version of the scale.

Table 4
Internal Consistency Reliability Comparison – Cronbach's alpha

	Original	Icelandic translation
M	.72	.68
U	.80	.87
S	.84	.83
I	.77	.86
C	.85	.88

Note. The following abbreviations are used: M = eMpowerment, U = Usefulness, S = Success, I = Interest, C = Caring. The alphas from the original version referenced were obtained from Jones, Sahbaz, and Chittum (2015).

Construct Validity

I conducted a CFA to examine how the items in the MMAMI-Icelandic fit the five-factor structure of the MUSIC model. I 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; Bryne, 2001, Kline, 2005), and SRMR = 0.05 (0-1, where < .05 is good, and < .1 is reasonable). Figure 1 shows the model tested. 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.

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, C = Caring.

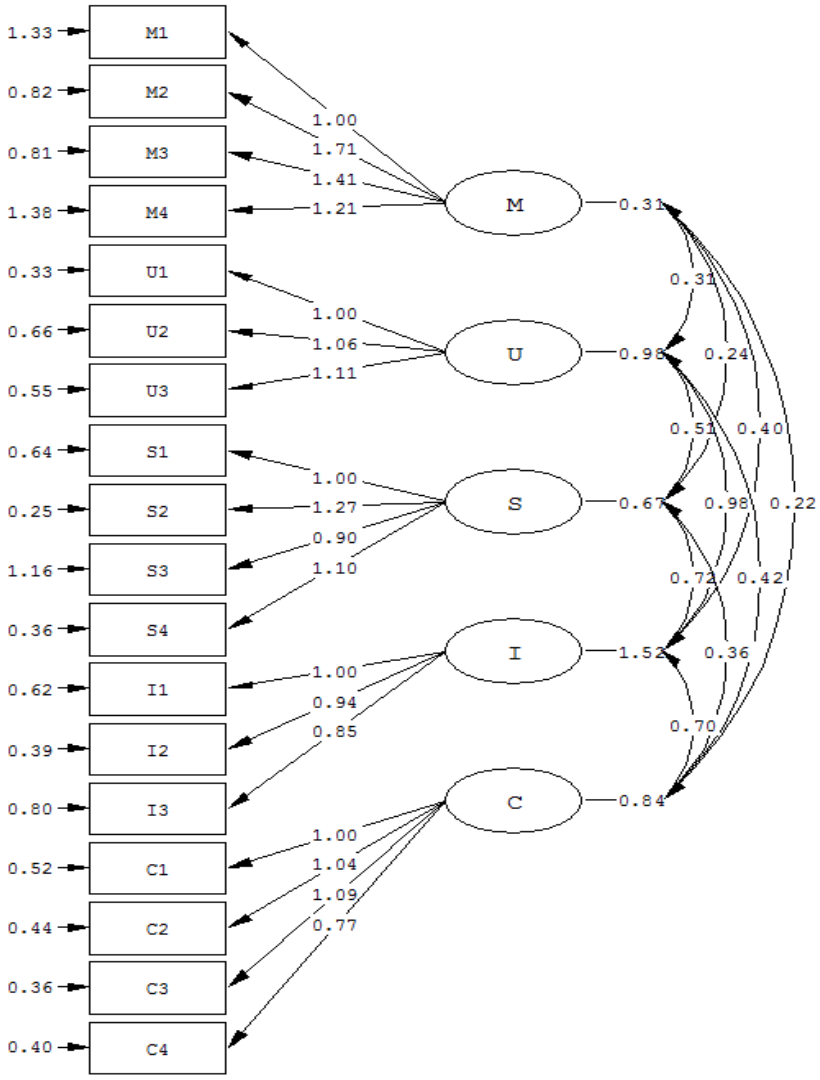

Figure 1. The items in the MUSIC Model of Academic Motivation Inventory–Icelandic version hypothesized as a hierarchical intercorrelated five-factor structure comprised of empowerment (M), usefulness (U), success (S), interest (I), and caring (C).

Discriminant/convergent validity. Even though the CFA indicates statistically that the data fits 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 MMAMI subscales. The five subscales were moderately correlated as was expected, and this 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	.91	1.1	.95	1.2	.95

**Correlation is significant at the 0.01 level (2-tailed).
Note. Values in parentheses are from the English version of the MMAMI (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 did the original version of the MMAMI. The correlations were generally lower between items of separate subscales than items within the same subscale. Even though correlations between some items were on the higher side, the results from the *CFA* indicate that statistically the items in the same subscale correlate higher among themselves than with ones in the other subscale.

Table 7

Correlations (Pearson's) 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.

Chapter 5: Discussion and Implications

Validity Evidence

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

The Cronbach's alpha values for each MMAMI-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 according to Robinson, Shaver and Wrigtsman (1991) is exemplary. One factor 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 I 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 sociobehavioral research (Tabachnick and Fidell, 1996), others have suggested that loadings exceeding .4 or .5 are more meaningful (Costello & Osborne, 2005; Pedhazur & Schmelkin, 1991). As my goal was to reach a factor loading closer to .5 for each factor, similar to the original version, I revised these three items, as

well as one additional item that had caused some confusion among the participants during data collection.

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

In addition to providing validity evidence for the MMAMI-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 appear to be universal and not simply a product of the U.S. culture. Future studies could examine whether the five-factor structure of the MUSIC model is consistent across other cultures as well.

Uses of the MMAMI-Icelandic

The results of the reliability analysis and factor analyses provide strong evidence for the validity of the scores produced by the MMAMI-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. One of the rationales for conducting this study was the need to respond to students' low level of motivation and inadequate scientific literacy in compulsory

schools (Halldórsson et al., 2007, 2013). The middle school years are important in building scientific literacy and foundations for further studies. The MMAMI-Icelandic could be a valuable tool for researchers to measure middle school students´ motivation and respond with suggestions for improvement. It might, for example, be used to compare motivation levels in various teaching environments, such as teacher-centered versus student-centered classrooms, or to compare the traditional lecture approach to inquiry learning. The results could inform educational policy in Iceland and possibly increase motivation and scientific literacy in middle school, science classes.

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). 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 MMAMI-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 MMAMI-Icelandic could alert the teacher to the extent to which students perceived empowerment in the classroom or if 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.

Educators are concerned with the decline in number of students who choose science courses or programs in high schools and universities (Cleaves, 2005), especially because of the

projected need for students with science backgrounds in the future work market (PCAST, 2012). If teachers could use the results from the inventory to guide them in triggering interest and enjoyment in the classroom, those factors combined with the other MUSIC components might increase students' motivation. Because increased perceptions of the MUSIC components have also been shown to foster domain identification (Jones, Ruff, et al., 2015), teachers' efforts to increase students' motivation could also lead to more students' identifying with the subject area. That is, students might develop an individual interest in science and come to value the field. This could increase the likeliness of them selecting science as their career (Jones, Ruff, et al., 2015).

Even though the inventory is designed for science students, the word science can be replaced with another subject, such as music (Parkes, Jones, & Wilkins, 2015). Thus, the implications for using this inventory could extend to other subjects beyond the discipline of science. The MMAMI has now been translated from English into two other languages, Arabic (Mohamed et al., 2013) and Icelandic. Instruments that have been translated into several languages give the possibility of cross-cultural comparisons, revealing the strengths and weaknesses of nations' educational systems, and thereby aiding in the development of good education practices internationally.

Future Research

Villagran and Lucke (2005) suggested that the strongest way to influence the equivalence of the results of an instrument translation is to have a bilingual sample complete both language versions, in this case, both Icelandic and English, and subsequently compare their responses to items. This was not possible in my data collection with middle school students because most of them were not bilingual. This approach could, however, be used in future research with older

students who are bilingual. It might be possible to recruit Icelandic students, who are studying or have studied in the US, to participate in this type of study.

It would also be interesting to use the MMAMI to compare motivation levels in various teaching environments. More experimental research is needed to study the relationship between motivation and teaching strategies, for example, student-centered versus teacher-centered strategies. Several studies indicate that student-centered strategies, especially inquiry strategies, possess more of the motivation factors than the teacher-centered strategies. Because most of the participants in these studies are older than middle school students (Hmelo-Silver, 2004), future researchers could examine whether these findings hold true for middle school students as well. Unfortunately, many middle school studies have been small scale and few have use experimental or semi-experimental designs. It may be possible to improve on the design of these studies.

Another research question that I 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 stay similar. Administering the inventory throughout a year would allow researchers and teachers to determine how much students' perceptions changed over time.

Assumptions and Limitations

Some assumptions underlie this study. Based on the success of prior translations of student questionnaires from the United States, I am assuming that the differences between the Icelandic culture and the American culture did not influence responses, and that Icelandic students are similar in their personality dispositions to American students. I also believe that students answered the questionnaire items honestly and that issues, such as social desirability or

lack of background knowledge and understanding of the items, were minimal, so as not to significantly affect the results of the study. Finally, my sample was limited to 448 Icelandic students from five public schools. However, public schools in Iceland share more similarities than differences, so these five schools should be representative of public schools in Iceland.

Conclusion

My motivation for conducting this study derived primarily from my own experiences with students' motivation, or lack thereof, during my career as a middle school teacher and an assistant principal. As a committed teacher, I gathered some information at the time on how to encourage students to study, an area that had not been a substantial part of my teacher preparation. Often I succeeded in motivating my students but sometimes not, and I wondered how students perceived my teaching methods and environment. I would have appreciated having had access to a tool like the MMAMI.

It seems that student motivation in middle school should not be bound to decline (Vedder-Weiss & Fortus, 2011). As teachers, we are also researchers and evaluators of our own success. MMAMI-Icelandic could make it possible for 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 MMAMI guides teachers in the process of determining where the need is for improvement.

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Appendix A

The middle school version of the Music Model of Academic Motivation Inventory (Jones, 2012)

These items ask you about your current science class. Please select one of the numbers from 1 to 6 below.

1 Strongly disagree	2 Disagree	3 Somewhat disagree	4 Somewhat agree	5 Agree	6 Strongly agree

1. _____ I had choices in what I was allowed to do in science class.
2. _____ The knowledge I gained in science class was important for my future.
3. _____ I am capable of getting a high grade in science class.
4. _____ I had the freedom to complete my science class work in my own way.
5. _____ My science teacher was respectful of me.
6. _____ In general, science class work was useful to me.
7. _____ I was confident that I could succeed in science class work.
8. _____ I had control over how I learned the content in science class.
9. _____ During science class, I felt that I could be successful on the class work.
10. _____ The science class work was interesting to me.
11. _____My science teacher was willing to assist me if I needed help in science class.
12. _____ I enjoyed completing the science class work.
13. _____ I felt that I could be successful in meeting the academic challenges in science class.
14. _____ I had options in how to achieve the goals in science class.
15. _____ My science teacher cared about how well I did in science class.
16. _____ The science class work held my attention.
17. _____ My science teacher was friendly.
18. _____ I found science class work to be relevant to my future.

Other items added to the questionnaire completed by students during the second data collection:

Write X: 5^{th} gr _____ 6^{th} gr _____ 7^{th} gr_____ 8^{th} gr _____

male _____ female _____

I have a father of foreign origin _____ I have a mother of foreign origin _____

Appendix B

The Music Model of Academic Motivation Inventory-Icelandic version for middle school students

Þessi atriði eru um **náttúrufræðitímana í vetur**. Veldu stig á skalanum frá 1 og upp í 6.

1 Mjög ósammála	2 Ósammála	3 Nokkuð ósammála	4 Nokkuð sammála	5 Sammála	6 Mjög sammála

1. _____Ég hef svolítið val um hvað ég geri í náttúrufræðitímum.
2. _____Það sem ég læri í náttúrufræðitímum er mikilvægt fyrir framtíð mína.
3. _____Ég get fengið háa einkunn í náttúrufræði.
4. _____Ég hef frelsi til að klára vinnuna í náttúrufræði á minn eigin hátt.
5. _____Náttúrufræðikennarinn minn sýnir mér virðingu
6. _____Mér finnst ég almennt hafa gagn af því sem ég er að læra í náttúrufræðinni.
7. _____Ég er viss um að ég get náð góðum árangri í náttúrufræði.
8. _____Ég ræð því hvernig ég vinn með eða læri námsefnið.
9. _____Mér finnst ég geti náð góðum árangri í náttúrufræði.
10. _____Ég hef áhuga á námsefninu í náttúrufræði.
11. _____Náttúrufræðikennarinn er tilbúinn að hjálpa mér ef ég þarf á hjálp að halda.
12. _____Ég hef ánægju af að sinna vinnunni í náttúrufræði.
13. _____Mér finnst ég geti ráðið við það sem ég á að gera í náttúrufræði.
14. _____Ég get klárað vinnuna í náttúrufræðinni á ýmsan hátt.
15. _____Náttúrufræðikennarinn minn vill að mér gangi vel í tímum.
16. _____Vinnan í náttúrufræðitímum heldur athygli minni.
17. _____Náttúrufræðikennarinn minn er vingjarnlegur.
18. _____Mér finnst vinnan og námið í náttúrufræðitímum vera þýðingarmikið fyrir framtíðina.

Merktu X 5.b. _____ 6.b _____ 7.b _____ 8.b. _____

kk _____ kvk _____

Ég á útlenskan föður _____ Ég á útlenska móður _____

Appendix C

Directions for the MMAMI-Icelandic:

To Principals and teachers: Thank you very much for your willingness to participate in this study. We appreciate the time that you have given us. Here are some directions for the process: Students should fill out the inventory the last 10-15 minutes of the lesson. It would be beneficial to have some copies on pale yellow paper for students with special needs, such as dyslexia. Special needs students can have personal assistance. However, the science teacher should not assist them since some of the items deal with the student's perception of the science teacher. The teacher hands out the inventory and reads the following directions:

Dear students,

We are researchers, one Icelandic and one American, wanting to know what you think about your studies. Among other things, we would like to know if you find your studies useful and if you feel successful. Educators are concerned with making our schools in Iceland even better and that is why it is important for us to know how you are experiencing school. No one is obliged to participate, but we would be very thankful if you would fill out this one page of questions.

You do not need to write your name on the paper. We want the research to be anonymous. About 450 students fill out the questionnaire and no one knows who fills out what form. We would like you to be honest, to say exactly what you think. The questions are about your science classes this year, including biology, chemistry, physics, animal studies, plants, or just anything that has to do with nature and science. Maybe your sciences classes are over, but then think back and try to remember how you felt. You only need to put in a number from one to six depending on if you disagree or agree.

When you are done filling out the questionnaire, just put it in the big envelope on your way out of the room. Be careful not to disturb anyone else who is still working. Thank you very much for participating.

Asta and Brett

To Principals and teachers: It is important that students know that their forms are anonymous and go right into an envelope after they fill them out. Teachers are free to take a look at an inventory form, but we ask that they will not be distributed to others, since the inventory is only in the process of being validated.

This purpose for the development of this inventory is to provide researchers and teachers with a tool that could be used to further our knowledge of how to influence student motivation. Subsequently, the results could be used to inform teaching and classroom management strategies. We really appreciate your assistance in accumulating these data. Thank you very much!