Presentation

The Making of a Mathematician: Comparing Mathematics Identities in the United States and Norway

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Abstract: This study compares two mathematics identity scales across first-year mathematics students from the United States (US) and Norway, with a particular focus on first-generation college students (FGCS). The research examines the applicability of Cribbs et al.’s (2015) and Kaspersen’s (2018) models of mathematics identity in these two international contexts. Both surveys assessed constructs such as interest, performance/competence, and recognition. The results revealed significant differences between students from the US and Norway in their reported interest in mathematics, with Norwegian students scoring higher. However, no significant differences were found in other constructs such as performance/competence or recognition, nor in the overall mathematics identity scores from Cribbs et al.'s model. In contrast, students from the US scored higher than students from Norway on Kaspersen’s model, indicating stronger self-identified mathematics identities. These findings suggest that while the instruments measure similar aspects of mathematics identity, they are not fully transferable across the two contexts. The study lays the groundwork for future research on cross-cultural variations in and educational structures that shape mathematics identity and its connection to competencies.

Keywords:
Mathematics identity, first-generation college students, first-year mathematics students, international comparative education

1 Introduction

With the rapid evolution of technology and the challenges it brings, there has been a growing call to teach 21st-century skills and competencies (Abina et al., 2024). One such effort is the 21st-century competency framework for STEM students developed by Lavi and colleagues (2021) through a quantitative study. This framework comprises three constructs: domain-general skills (e.g., problem-solving, critical thinking), soft skills (e.g., creativity, collaboration), and STEM-specific skills (e.g., STEM knowledge, experimenting). However, one thing this competency framework does not address is the connection to domain identities, such as mathematics identity, which are linked with student achievement and skill development (Bohrnstedt et al., 2021). Mathematics identity frameworks have been deeply rooted in sociocultural perspectives focused on the connections between individuals and mathematics, peers, and the larger societal context (Voigt et al., 2022). Due to these sociocultural perspectives, mathematics identity frameworks vary across different contexts, including international contexts. In this study, we aim to compare a mathematics identity scale from the United States (US) (Cribbs et al., 2015) to a mathematics identity scale from Norway (Kaspersen, 2018) across the two international contexts with a focus on first-year mathematics students broadly and first-generation college students (FGCS) specifically. This research study arises from a larger dissertation study investigating the societal and structural impacts within the US and Norway on FGCS, defined as students whose parents or guardians did not obtain a bachelor's degree. For this study, we are interested in answering the following research questions:

a) How do first-year mathematics students in the US and Norway score across the two models of mathematics identity?
b) How do first-generation college students in the US and Norway score across the two models of mathematics identity?

2 Theoretical Framing

Cribbs and Colleagues' Model of Mathematics Identity

Originally modeled after a qualitative model of science identity (Carlone and Johson, 2007), the Cribbs and colleagues' (2015) mathematics identity model includes three constructs: interest, performance/competence, and recognition. The construct of interest evaluates students' fascination and curiosity of mathematics through binary response statements like "I enjoy learning math," "Math is interesting," and "I look forward to taking math" (Cribbs et al., 2015). Similarly, performance/competence is defined as how well students are understanding mathematics and is measured through binary response statements, including "I understand the math I have studied," "Math makes me nervous," "Setbacks do not discourage me," and "I can do well on math exams" (Cribbs et al., 2015). Lastly, recognition captures peers', instructors', and students' perception of being "good at mathematics" by asking the 5-point Likert scale question "Do the following people see you as a mathematics person?" with the prompts of “Parents/relatives/friends,” “Mathematics teacher,” and “Yourself” (Cribbs et al., 2015).

Kaspersen’s Model of Mathematics Identity

Although Kaspersen’s (2018) model also measures mathematics identity, the instrument is uni-dimensional, meaning that the instrument evaluates mathematics identity as its own construct. We describe Kaspersen’s (2018) scale as having questions rooted in interest, performance/competence, and persistence. The scale includes the following questions: “I take the initiative to learn more about math than what is required at school/work,” “Math ideas that I hear or learn about help me inspire new trains of thoughts,” “I can explain why my solutions are correct,” and “When I work with a math problem, I move back and forth between various strategies” (Kaspersen, 2018). Kaspersen (2018) defined mathematics identity as something that can be measured, is context dependent, and ultimately, flexible; individuals' mathematics identity can change over time in relation to courses, peers, instructors or society.

3 Methods

Data Collection

At the end of the Fall 2024 semester, a survey consisting of Cribbs and colleagues’ (2015) and Kaspersen’s (2018) mathematics identity instruments was emailed to all first-year mathematics students (N = 1,848) at a large, research intensive university in the Southeastern US. The survey collected 266 viable responses. At the beginning of the Spring 2025 semester, the same survey was distributed via Canvas and a QR code in a first-year mathematics class for STEM majors at a medium-sized, STEM-based university in Southern Norway. The survey collected 80 viable responses. Responses were deemed viable if participants fully answered the questions corresponding to the two mathematics identity scales. Participants who left one or two blank responses in Kaspersen’s (2018) scale were counted as “I don’t know” which was an option in the scale.

Data Analysis

We performed descriptive statistics to determine how US and Norwegian first-year mathematics students and FGCS responded to the two mathematics identity scales. For Cribbs and colleagues’ (2015) scale, we calculated the mean score for each construct (e.g., performance/competence, interest, and recognition) and an overall mean score for mathematics identity. Due to the uni-dimensional nature of Kaspersen’s (2018) mathematics identity scale, we calculated a mean score for the entire scale. We used a Shapiro-Wilk test to check for a normal distribution for the recognition construct and overall mathematics identity score from the Cribbs and colleagues’ model (2015) as well as Kaspersen’s (2018) model. The interest and performance/competence constructs of the Cribbs and colleagues’ (2015) model contained a series of binary (agree/disagree) questions which prevented the data from having a normal distribution. To calculate the difference between means, we used a Student's t-test for normally distributed items and a Mann-Whitney U Test was used for non-normally distributed data.

4 Results

We sought to determine if all students and first-generation college students in first-year mathematics from the US and Norway performed similarly across the two models of mathematics identity. The following section presents descriptive statistics for key variables of interest, including measures of central tendency, variability, and statistical significance.

Descriptive statistics for first-year mathematics students across both mathematics identity instruments are shown in Table 1. The students from the US had a mean interest score of 0.76 (SD = 0.34), while the students from Norway had a mean interest score of 0.87 (SD = 0.26). A subsequent Mann-Whitney U test revealed a significant difference in interest between the US and Norwegian first-year mathematics students, U(266,80) = 8809, *p* = .007. For performance/competence, students from the US had a mean score of 0.69 (SD = 0.30) while students from Norway had a mean score of 0.73 (SD = 0.28). The difference in performance/competence was not significant, U(266,80) = 10033, *p* = .420. Similarly for the construct recognition, the two means were not significantly different, U(266,80) = 10480, *p* = .839, with a mean score of 4.06 (SD = 1.20) for students from the US and a mean score of 4.08 (SD = 1.08) for students from Norway. The composite mathematics identity scores were not significantly different, U(266,80) = 10085, *p* = 0.480. These results demonstrate a significant difference in the interest construct and insignificant differences in performance/competence, recognition, and overall identity across all first-year mathematics students from the US and Norway.

Using Kaspersen's (2018) model, first-year mathematics students from the US had a mean of 2.70 (SD = 0.50) and students from Norway had a mean of 2.53 (SD = 0.46). The means showed a statistically significant difference, t(344) = 2.68, *p* = .008, demonstrating that students from the US were responding more positively to Kaspersen's (2018) model than students from Norway. Thus, having a higher self-identified mathematics identity.

Table 1. *Descriptive statistics of the constructs of Cribbs et al.'s (2015) mathematics identity model and Kaspersen's (2018) model across all first-year mathematics students. Constructs of Cribbs' model shown in light gray; unidimensional Kaspersen's model shown in dark gray.*

	United States (n = 266)	**Norway (n = 80)**	**Mann-Whitney U Test Results / Student's T-Test Results**
Interest	*M* = 0.76 (*SD* = 0.34)	*M* = 0.87 (*SD* = 0.26)	U(266,80) = 8809 *p* = .007**
Performance/ Competence	*M* = 0.69 (*SD* = 0.30)	*M* = 0.73 (*SD* = 0.28)	U(266,80) = 10033 *p* = .420

Recognition	*M* = 4.06 (*SD* = 1.20)	*M* = 4.08 (*SD* = 1.08)	U(266,80) = 10480 *p* = .839
Cribbs' Overall Model	*M* = 1.84 (*SD* = 0.54)	*M* = 1.89 (*SD* = 0.44)	U(266,80) = 10085 *p* = .480
Kaspersen's Model	*M* = 2.70 (*SD* = 0.50)	*M* = 2.53 (*SD* = 0.46)	t(344) = 2.68 *p* = .008*

*Statistically significant at p <.05, **Statistically significant at p <.01

Results for FGCS across both mathematics identity instruments are shown in Table 2. A comparison of FGCS in the US and Norway revealed no significant differences in their responses to Cribbs et al.'s (2015) model constructs or overall score. While Norwegian FGCS showed slightly higher mean scores for interest (0.88, SD = 0.26) compared to their US counterparts (0.83, SD = 0.31), this difference was not statistically significant (U(37,24) = 418.5, *p* = 0.639). A similar pattern emerged for performance/competence, with US FGCS averaging 0.66 (SD = 0.33) and Norwegian FGCS averaging 0.74 (SD = 0.27), again with no significant difference (U(37,24) = 385.5, *p* = 0.373). Recognition scores were nearly identical between the two groups, both averaging 4.04 (US SD = 1.17; Norway SD = 0.94), and were also statistically insignificant (t(59) = -0.020, *p* = 0.984). Finally, the overall model scores showed no significant difference between US FGCS (1.84, SD = 0.53) and Norwegian FGCS (1.89, SD = 0.38) (t(59) = -0.14, *p* = 0.889). In regards to FGCS, Kaspersen's (2018) model was not statistically significant across countries, t(59) = 0.86, *p* = .395. First-generation college students from the US had a mean of 2.79 (SD = 0.49) while FGCS from Norway had a mean of 2.68 (SD = 0.46).

Table 2. *Descriptive statistics of the constructs of Cribbs et al.'s (2015) mathematics identity model and Kaspersen's (2018) model across all first-generation college students.*

	United States (n = 37)	**Norway (n = 24)**	**Mann-Whitney U Test Results / Student's T-Test Results**
Interest	*M* = 0.83 (*SD* = 0.31)	*M* = 0.88 (*SD* = 0.26)	U(37,24) = 418.5 *p* = .639
Performance/ Competence	*M* = 0.66 (*SD* = 0.33)	*M* = 0.74 (*SD* = 0.27)	U(37,24) = 385.5 *p* = .373
Recognition	*M* = 4.04 (*SD* = 1.17)	*M* = 4.04 (*SD* = 0.94)	t(59) = -0.020 *p* = .984
Cribbs' Overall Model	*M* = 1.84 (*SD* = 0.53)	*M* = 1.89 (*SD* = 0.38)	t(59) = -0.14 *p* = .889
Kaspersen's Model	*M* = 2.79 (*SD* = 0.49)	*M* = 2.68 (*SD* = 0.46)	t(59) = 0.86 *p* = .395

5 Discussion

By comparing mathematics identity across different international populations, we will gain a greater perspective of how mathematics identity varies across different societal and educational contexts. For example, we found that first-year mathematics students from Norway had a greater interest (Cribbs et al., 2015) in mathematics than their US counterparts. This finding prompts us to question what is going on in the first-year mathematics course at the Norwegian university that is sustaining students' interest in mathematics and how we can reproduce those results in the context of the US. The remaining constructs and overall result for Cribbs and colleagues' (2015) model proved to not be statistically different providing the context that although Norwegian students are more interested in mathematics, their overall score is not distinctly different from US students. Similarly, students from Norway and the US have comparable perceptions of their performance/competence in mathematics and recognition of themselves as a "mathematics person." In terms of Kaspersen's (2018) model of mathematics identity, students from the US and Norway responded differently to the instrument. Students from the US responded more strongly than students from Norway, emphasizing that they self-identified as having a stronger mathematics identity. This difference may stem from variations in the structure of first-year mathematics courses and differing cultural beliefs around self-perception in mathematics ability.

Although both instruments are intended to measure mathematics identity in their distinct contexts (the US and Norway), both were not fully transferable across contexts shown by the statistically significant differences in responses by the two populations. We recognize that limitations of the study include the small sample size from one institution in each country and that additional contexts in the US and Norway would be beneficial to proving generalizability across the two instruments. As part of the larger dissertation study that the data are from, we plan on utilizing this information to conduct an exploratory factor analysis to assess the factor structure of each instrument across the two populations and determine if the two instruments are measuring the same version of mathematics identity across the two populations.

6 Discussion Questions:

- Why is mathematics identity important when educating mathematics students?
- How do you currently foster mathematics identity in your classroom?

Acknowledgements

This paper would not have been possible without the efforts of Thomas Gjesteland and Svitlana Rogovchenko.

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