Understanding Students' Experiences and Social Perceptions of Their Peers in Linguistically Diverse Mathematics Classrooms

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In order to gain insight into the experiences and social perceptions of university students regarding their peers in mathematics classrooms that are linguistically diverse, this study employs interviews with three undergraduates. The results suggest that students' mathematical learning could be significantly impacted by the languages spoken by their peers, while their engagement in classroom discussions could be influenced by their cultural backgrounds.

I am interested in this topic because of my educational and linguistic background. I have a bachelor's degree in applied physics and a master's degree in Teaching English to Speakers of Other Languages (TESOL). In addition, I am a non-native English speaker who has lived and studied in English-speaking countries for several years. Consequently, I am aware of the challenges and problems that arise in a mathematics classroom with a diverse student body. During my studies at the University of Washington in Seattle, the mathematics courses included tutorial sections that encouraged peer discussion. An international student never spoke during group discussions. He seldom participated in the group conversation, but whenever I asked a difficult question, he could always provide an accurate response. Posing the question, “why do you never participate in lesson discussions?” they responded that English is not their native tongue and that they don’t know what others will believe. Therefore, I wish to explore students’ experiences and how they perceive one another during mathematical discussions.

Although numerous scholars have studied views and attitudes in mathematical instruction up to this point (e.g., Deale & Lee, 2022; Riegle-Crumb & Humphries, 2012), students' perceptions of their peers in linguistically diverse mathematics classrooms have gotten little consideration. More research is needed to understand the connection between student perception and language diversity in undergraduate mathematics instruction.

This investigation is predicated on a broad research question: What are students’ experiences and social perceptions of their peers in linguistically diverse mathematics classrooms?

Literature Review

Perception

Perception is defined as "the way an individual observes, understands, interprets, and evaluates a referent object, action, experience, individual, policy, or outcome" (Bennett, 2016, p. 585), and social perception specifically refers to the perception of another person (Heider, 1964). Perception is a complex concept that ought not to be confused with attitude or opinion. Instead, it should be perceived as a compilation of sensory encounters that are susceptible to influence from various elements, including cultural heritage, socioeconomic status, and individual characteristics (Bennett, 2016).

However, social perception research has not received sufficient attention in the realm of undergraduate mathematics education. Despite the fact that two relevant studies have been identified, they were not conducted in the field of mathematics. Ali et al. (2008) examined the perspectives of numerous students regarding learning environments. University students of

various races and ethnicities favoured more interactive classrooms, according to the findings. During a semester-long group project, Summers and Volet (2008) investigated college students' perspectives on culturally diverse study groups. The findings indicate that the positive attitudes of students toward multicultural group work were influenced by their experiences in multilingual settings. Furthermore, academic inquiries that concern social perceptions have conducted distinct analyses on students who identify as "local" and those who identify as international. The studies in question assumed that domestic students were the norm, thus implicitly classifying the group of international students. To ensure objectivity, the nationality or ethnic background of the students was not considered in the present inquiry.

Linguistically Diverse Classrooms

The domain of higher education has experienced significant growth, especially in the Anglophone world, as a result of globalization and increased opportunities for enrollment. Linguistic diversity has grown because of this development (Preece, 2009, 2019). Extensive scholarly research has recognized the importance of language in both the instruction and acquisition of mathematics (Austin & Howson, 1979; LeFevre et al., 2010; Secada, 1992). There has been a discernible increase in the utilization of multilingual discourse by educators and students during mathematics instruction in recent years (Barwell et al., 2017; Robertson & Graven, 2019). Barwell et al. (2016) assert that linguistic diversity is intrinsically intertwined with the domain of mathematics education. As a result, it is critical to acknowledge the significance of language diversity in mathematical education research (Chronaki & Planas, 2018). The existence of numerous types of mathematics classrooms may be inferred from the presence of linguistic diversity in mathematics education. Numerous students "are learners of the language of instruction or speak it as a second or additional language" in mathematics classrooms in nations including the United States, Canada, Australia, and New Zealand (Barwell, 2020, p. 150). The second category of mathematics classroom is frequently encountered in regions and countries with a historical association with colonialism or that adhere to a global educational framework. Illustrative instances of such regions and countries comprise, among others, India, Hong Kong, Uganda, Singapore, and Malaysia. A form of linguistic variation, the last category of mathematics classrooms comprises students who speak different dialects of a common language (Barwell et al., 2017).

A considerable number of scholars have made efforts to analyze the phenomenon of language diversity by employing language-as-resource perspectives (Lin, 2013; Preece et al., 2018; Marshall & Moore, 2013). Bruen and Kelly (2017) conducted a study examining the foreign language learning experiences of university students. The findings revealed that non-native English speakers held the perception that they were in a favourable position relative to native English speakers, notwithstanding the English language of instruction. The researchers postulated that non-native English speakers' greater linguistic repertoire, which facilitated their language-learning, was the cause of this phenomenon. However, it is critical to acknowledge that university students may not always benefit from language diversity. Preece (2019) posits that the impact of linguistic diversity in higher education institutions differs among students on the basis of socioeconomic status, stating that individuals belonging to "higher socio-economic groupings" (p. 416) were more likely than students from "working-class backgrounds" to perceive their multilingual abilities as advantageous. However, scholarly investigations into the topic of multilingualism in academic institutions remain uncommon (Schroedler, 2020, p. 134).

Methodology

Participants

Three participants are University of Ottawa students. Iron Man (pseudonym) is a first-year mechanical engineering student who is bilingual in English and French; he participated in an extended French program in Ontario during his senior year of high school. Hulk (pseudonym) is a business student in her third year who is bilingual in English and Chinese. She attended high school in Uganda. Thor (pseudonym) is a mathematics student in his third year who is bilingual in English and Chinese and attended high school in Canada. All three participants have taken high school and college-level mathematics courses. Thor revealed he had studied French as his third language. Hulk revealed that she was exposed to more than five languages.

Procedure

I invited the three participants to participate in my project via email. Thor declined to participate in an in-person interview and instead chose to respond to a questionnaire, which included seven open-end questions; he returned his response and consent form via electronic transmission. A week before the semi-instructed interviews, the other two participants received a list of preliminary interview questions. The interviews took place in a campus study room. They signed the consent form prior to beginning the interview. The interview was captured on audiotape. The Iron Man's interview lasted 12 minutes, while the Hulk's interview lasted 28 minutes. More information was obtained from the two in-person interviews in comparison to Thor's reply.

Analysis

The purpose of the analyses is to comprehend the experiences and perceptions of the participants in linguistically diverse mathematics classrooms. The interview data from the audio recordings was transcribed into a Microsoft Word document. The data were coded using NVIVO into four categories: educational background, language background, mathematics experience, and multilingual experience. The four categories emerged from the data. Under the mathematics experience category, a perception category was created to identify the responses of participants regarding their peers.

Results

Participants' Experiences in Linguistically Diverse Mathematics Classrooms

The first theme captured the experiences of participants studying mathematics in multilingual environments. Hulk and Thor have been studying mathematics in their second languages for over six years, and both acknowledged that they were "pretty good" at mathematics in high school; they believed that their prior mathematics education in China was the reason for their success. As a non-native English speaker, Thor acknowledged he "experienced anxiety while studying mathematics in high school." He stated that speakers of a second language must always translate everything into their native tongue in order to comprehend. Hulk was also perplexed when her teachers were unable to answer her questions; she was uncertain as to whether they did not understand her or lacked the language proficiency to explain it. While studying mathematics

in French, Iron Man noticed that "the naming for some stuff is different." For instance, eighty is *quatre-vingt* in French, which is "logical" to "anyone who has been doing French for years."

Additionally, Hulk discussed her experiences with two university mathematics professors. The first professor was a French-native speaker who instructed in English. His "strong accent" prevented Hulk from comprehending him. In fact, Hulk discovered that "some students could not really understand the professor," and after the midterm, they decided to attend the second professor's class. The second professor, from India, had an accent, but Hulk believed "she [taught] better" and "[knew] what she [was] doing." While the first professor "used words to teach," the second professor "showed procedures" and "highlighted key points." Similarly, Iron Man praised his 12th grade mathematics instructor, stating that "she knew what she was doing."

Participants' Perceptions of Their Peers in Linguistically Diverse Mathematics Classrooms

The second theme focuses primarily on how participants perceive their peers. Thor and Hulk discussed their negative encounters with mathematical discussions in linguistically diverse classrooms. Thor stated that discussions in high school did not result in "significant improvement" because not everyone took them seriously. Hulk viewed her high school classmates as "stubborn" because they always spoke about something else during class discussions. She also noted that the majority of those who participated in the discussion were "fluent in English." An important observation made by Hulk was that "Korean students and Chinese students knew how to do the questions,' but chose to remain silent. Thor expressly stated that "East Asian students" typically did not express their opinions. Thor and Iron Man concurred that discussing mathematics in a second language can be challenging and uncomfortable, but "when it comes to problem-solving, mathematical skills vastly outweigh language proficiency."

Findings

While all three participants studied mathematics in their second languages during secondary school, Iron Man reported fewer linguistic difficulties than Thor and Hulk. It is possible that Hulk and Thor had a harder time discussing mathematical problems with their peers. In high school, all of Iron Man's classmates spoke English, his native tongue. In contrast, Thor and Hulk's peers spoke languages that were not their native tongues, including English, French, Korean, Japanese, Swahili, Urdu, Indonesian, and Arabic. Even though Iron Man and his peers studied mathematics in a second language, they were still able to communicate and help one another in a language in which they were "comfortable" with. In contrast, Hulk and Thor were required to communicate with their peers in a language that was foreign to everyone. Hulk admitted that she desired to assist her struggling classmates in mathematics, but her limited oral proficiency prevented her from doing so. It is possible for high-achieving students to want to help low-achieving students but be unable to do so due to language barriers.

In addition to linguistic differences, three participants' cultural backgrounds may have influenced their participation in mathematical discussions. Hulk observed that "East Asian students" exhibited reluctance in class discussions despite being able to answer the question being debated. These students did not actively participate, but "[would] answer" if other students asked them a question. Similarities exist between these students and those described by Chung's (2021) study. According to Chung (2021), Thai university students believed they participated "attentively" (p. 62) but quietly. Cheng (2000) also argued that Asian students were not passive

learners; rather, they had a "strong desire to participate in classroom activities" (p. 435) that was constrained by their limited language proficiency and unfamiliarity with teaching methods. Frambach et al. (2014) discovered that Hong Kong high school students were less inclined to participate in discussions, pose inquiries, or challenge their peers due to their inclination to preserve "their own and others' face in front of the group" (p. 1012). This finding supports previous research into mathematical discussions which believed mathematical discussions enhanced students' "thinking and reasoning skills" (von Renesse & Ecke, 2015, p. 222) and mathematical performance (Giberti et al., 2022; O'Connor, 2002; Setati, 2005).

Reflections

The complexity of conducting qualitative research in a linguistically and culturally diverse environment was an important lesson I learned from this project. In the interview, Thor stated clearly that the Canadian high school mathematics curriculum was "equivalent" to the Chinese middle school mathematics curriculum. As a result, the statement "I took four years of high school math" by students from various regions offers limited insight into the students' mathematical proficiency. While researchers are not expected to be conversant with every country's mathematics curriculum, it becomes crucial that participants precisely describe what they have learned (e.g., algebra, geometry, pre-calculus, etc.).

Second, despite the fact that Hulk and Thor's immigration statuses indicate that they are international students, their educational backgrounds differ greatly from those who have recently left their native countries. Moreover, many students may attend schools that exclusively prepare them for foreign education (e.g., international schools, language schools, schools with language immersion programs, etc.); these schools not only employ foreign languages (predominantly English) to instruct, but also adopt foreign curricula and teaching methods. When these students arrive in foreign countries, they are, in a sense, comparable to the domestic students. Future research should exercise caution when employing the term "international student" as it is too broad.

Thirdly, prior to conducting the interview, I assumed that all interviewees had participated in active and meaningful mathematics class discussions. However, they claimed that their discussions were meaningless, primarily as a result of the students' inattention. I have been reading tertiary-level research, ignoring the fact that high school students are distinct from adults. Furthermore, the interview questions I formulated were predicated on the premise that linguistic diversity within the educational setting exerted a noteworthy influence on students' acquisition of mathematical knowledge. However, one of the participants did not extensively elaborate on this particular aspect. In future research endeavours, it is imperative to refrain from making assumptions and instead prioritize conducting thorough investigations.

One implication derived from the present study is that educators and researchers in the field of mathematics should be cognizant of the efficacy of student interaction. According to the findings, engaging in peer discussions regarding mathematical questions can enhance an individual's comprehension. The efficacy of such discussions is significantly impacted by the linguistic abilities of the students involved. Hence, it is imperative for educators and researchers to be aware of the potential benefits that students' languages can offer in the context of mathematics education.

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