

The Teaching Strategies to Improve Students of Immigrants in STEM Learning within the K-6 Setting

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Abstract. With the growing population of immigrant students and the demands of STEM professionals in the U.S. labor market, the quality of STEM education (Science, technology, engineering, and math) for students with immigration backgrounds need to be addressed. This study focuses on how to support children of immigrants who are aged from kindergarten to sixth grade in their STEM learning within American classrooms. By reviewing 27 articles from 2003 to 2022, the research develops strategies to support this group's students in their STEM learning from the following perspectives: family engagement, linguistic culturally responsive teaching, and project-based integrated STEM learning. Firstly, the family engagement approach shows that the home-school connection provides a consistent STEM learning environment for the students. Secondly, the linguistic culturally responsive teaching reflects students' STEM identities and incorporates their interest in STEM learning. Lastly, the project-based integrated STEM learning strategies accommodate students' individual needs in their STEM learning and deepen their comprehension of each STEM subject.

Keywords: STEM learning; K-6 classroom; children of immigrants; teaching strategies.

1. Introduction

In recent decades, a mass of immigrants has settled down in many western countries like Australia, Canada, and the U.S. [1]. Despite the first-generation immigrants' contribution to the local society, their descendants are attending the local school and joining the local labor market in those countries [1,2]. Suárez-Orozco, Rhodes, and Milburn found that immigrant-oriented children are facing more social-emotional, adjustment, and health issues in schools than their native peers which put the immigrant-oriented children at risk of academic failure [3]. Thomas and Lonobile's study demonstrates that inequalities in children's STEM-related development are affected by parental STEM education level [4]. It also reveals that immigrant-oriented students' academic performance is significantly influenced by their parents' levels of STEM credentials compared to their U.S.-born peers [4]. Research has discovered that the academic performance of students with immigration backgrounds varies by the country that they originate from, for instance, black and Hispanic children lay behind the other ethnicities [5]. Although the existing research has pointed out the factors that impact immigrating children's academic performance, there are not sufficient studies to give suggestions on how to support these left-behind immigrant children [6]. To take a closer look at how to help the children of immigrants to be successful at school, this study will focus on what components of the school curriculum need to be addressed to support this group of students in their STEM learning.

Research also indicated that the immigrant orient children have a disadvantage in their parental educational background and educational setting of their home country [7]. In the meanwhile, research has concluded that the childhood period is the most important stage for students whose home language is not English in the U.S. to develop their school readiness skills like cognitive, linguistic, social-emotional, and reasoning skills [8]. Even though research has been detecting that elementary children of immigrants fall behind in cognitive skills than their native counter partners, there has been less previous research to summarize the approach to support this group of students to improve their cognitive related performance like science, technology, engineering, and mathematics (STEM) subjects [9].

Based on the above discussion, children of immigrants have more disadvantages than their native peers in their STEM learning in K-6 settings. Therefore, this study will focus on the approaches that classroom teachers can apply to enhance children of immigrants' STEM development in kindergarten and elementary settings.

2. Conceptual Background

2.1 STEM Curriculum in K-6 Classroom

Burton et al. demonstrate that STEM learning in schools would be critical preparation for students entering STEM majors in college and the labor market [10]. Their research highlights providing a robust and engaging STEM curriculum for students in K-6 setting will benefit them in various aspects (e.g., lifelong interests in STEM fields, inquiry and design thinking, mathematical literature skills) [10]. Johnson, Byrd, and Allison formulate the idea that an integrated STEM curriculum in K-6 environment support students to build up interdisciplinary project-based learning abilities, which facilitate their meta-cognitive skills like reflecting, analyzing, reasoning, and organizing [11]. English finds out in his research that offering a universal and equitable STEM curriculum for students in k-6 schools will make STEM education accessible for students from diverse backgrounds (e.g., socioeconomic status, ethnicity, and culture) [12].

2.2 Immigrant-Origin Students from 4 to 12 Years Old

Gagné et al. state that the sociodemographic status of immigrant-orient students in their home countries (e.g., gender, socioeconomic status, generational status, language proficiency, and migration class) influences their migrating experiences in the destined countries and, ultimately, their adjustment results in a variety of intricate aspects [13]. Jensen and Rasmussen discover that when compared to native-born students, immigrant children's academic performance is frequently shown to be inferior [14]. Weaker language skills, lower socioeconomic status, and school management are some of the contributing elements to this subpar performance. Chen and Tse reveal in their research that teacher-student relationships, self-perceptions, and peer acceptance play an important part in engaging this group of students to optimize their learning experience in their immigrant countries [15]. Moon and Hofferth find that higher parental involvement, child learning motivation, and socioeconomic status have a positive impact on immigrant children from k-5 after they migrate to a new country [16]. Research also expounds that children from immigrant families tend to speak their home languages rather than English and practice their heritage from the country of origin in the U.S. [16]. Children who speak their home languages but not English are defined as dual language learners, which are normally found in children of immigrant origin [17].

2.3 Method

This study discusses the strategies developed by summarizing a systematic review of the historical research literature and documentary evidence on how to apply STEM curriculum to support children of immigrants in a K-6 environment. The purpose of the review is to construct and synthesize practical classroom STEM teaching approaches for k-6 immigration students to gain notable STEM attainment in schools. A related goal is with the growing number of immigrant children in western countries, the research will serve as a tool for teachers in the frontline to support this group of students, who will be an important workforce for the future society. In addition, the study can inform school districts and departments of education on how to train pre-service teachers and allocate STEM educational resources for this increasing group of students. The study describes the teaching strategies from the following perspectives: parental engagement, linguistic and culturally responsive teaching, and project-based integrated STEM learning.

3. Strategies

3.1 Parental Engagement

Capotosto et al. found in their research that parents play an important part in developing students' linguistic skills, learning motivation, and habits by scaffolding the reading content explicitly, reading the books in children's home languages, and extending students' interests from the books [18]. By understanding these natures of parental engagement in children's learning, classroom teachers can apply multiple tactics to involve parents in their children's STEM learning. STEM learning is not just about doing experiments but also includes non-fiction reading. Therefore, teachers can assign weekly level-appropriate STEM reading books for individual children and create a list of questions for parents to ask when they read them with their children. Capotosto et al. research show that the high quality of interactions and conversation between parents and children when they do joint reading significantly benefits children's comprehension and reasoning about the books because parents know their children's interests as well as prior knowledge all around [18]. Further, teachers can share the current topics of STEM learning in the classroom and invite parents to borrow books in children's home languages about the content area. By using these strategies, some parents with higher language proficiency in their home languages rather than English will be empowered in engaging students' STEM learning equitably and support the students to comprehend the text in multiple languages. Following this approach, because children spend most of their time with their parents outside the classroom, teachers can also provide community STEM learning resources to the parents so that they can take their children to join these activities. Some of the immigrant families just come to the countries and they are unfamiliar with how to use the community resources, if the teachers can send out the community resources for this group of parents, it will help the children integrate into the local community.

Ma highlights in her research that the home environment setting has a positive relationship with immigrant students' STEM academic performance [19]. It talks about if immigrant parents have a clear understanding of schools' STEM teaching goals, immigrant parents demonstrate a tremendous desire to help their children succeed in STEM education. It is understandable that these parents come to seek better chances in a new country and are keen to support their children adapt to the new environment as well [19]. To implement this strategy, teachers can share the STEM curriculum teaching goals with parents so that they are able to set up the home STEM learning environment, purchase related materials, or attend some STEM workshops with their children. In order to help families better understand how learning happens in the classroom and to seamlessly connect learning at home and school, teachers can also send STEM learning newsletters to families on a regular basis. Delivering this information to immigrant parents will be very considerate and beneficial on the part of the teacher, as it is highly likely that these parents do not attend K-12 schools in their new countries and are unfamiliar with STEM education there. An informative newsletter can serve as a written and visual guide for parents to involve in supporting their children in STEM learning.

Mcwayne et al. emphasize the need for teachers to shift their perspectives to believe that parents are the experts on their children [20]. Therefore, teachers can propose to the parents that working together to develop a curriculum to better reflect the children's ongoing interest in STEM fields [20]. Teachers could use communication forms to show parents how their children are learning STEM topics in the classroom and ask them if they have any observations of their children's emergent interests in STEM areas at home. This will enable the teachers to incorporate those interests into the next curriculum planning circle. Since classroom teachers may be unfamiliar with the home cultures of immigrant children, regular check-ins with the families will allow teachers to understand more about the children's lives and personal experiences.

3.2 Linguistic and Culturally Responsive Teaching

Lee demonstrates in her research that children employ languages to learn STEM subjects, especially for those non-native speakers in the U.S. which consist of 9.6% of K-12 American public-

school students [19]. Lee suggests that teachers should facilitate one-to-small group and one-to-many interactions for language and background diverse students to enhance their STEM learning [20]. To make this strategy practical in classrooms with immigrant-orient students, the classroom teacher can form small groups discussion for students from similar cultural backgrounds or who speak the same languages. Thus, students are able to use translanguaging skills within the groups and support each other in STEM learning in multi-languages.

Fraser et al. point out in their research that schools can engage their students' STEM learning in a community-based approach, in which schools connect the community STEM industry institutions to invite them to be part of their STEM curriculum [21]. Because the local STEM network can represent the students' identities and foster their engagement in STEM learning, which is more significant for those high immigration density communities, inviting the community STEM representatives to school would promote immigrant orient students' sense of belonging in learning [21]. To implement this strategy, teachers can include the community STEM professionals to be guest speakers sharing their daily job. Schools can also collaborate with local STEM companies to hold open houses or field trips to raise students' interest in STEM learning. Charleston et al. further assert in their research that students with immigrant backgrounds need STEM learning role models that are their peers or adults from their home cultures or races in order to strengthen their STEM identity [22]. By involving community members in the students' STEM study, this group of children can reflect on these STEM mentors for their future careers and inspire them in STEM learning.

Inge et al. argue in their study that STEM curriculum and Culturally Responsive Teaching (CRT) have reciprocal benefits [23]. They believe that the CRT approach will make students' STEM learning meaningful and improve their participation in asking scientific inquiry questions as well as listening to the community members via community walk and talk [23]. The study also mentions about there are people who work in the STEM field from the community who may speak the same language as the children of an immigrant so that they can explain the STEM content to the students with multiple cultural lenses [23]. To improve the CRT in students' STEM education, classroom teachers should prepare themselves by participating in community STEM projects, such as community gardens and animal observation, so that they can extend the project's learning into the classroom. In addition, teachers can join the parent-teacher association to connect with parents who work in the STEM field and are willing to provide lessons about how their profession benefits the community. Particularly those parents who work in the STEM business in both their home countries and their host country will provide students with a global perspective to compare and contrast how the STEM industry is structured in various nations.

3.3 Project-Based Integrated STEM Learning

Research has proposed that when students are dealing with a design-based project, it's beneficial for the students to solve the tasks in a cross-subjects unit approach, which means they are applying knowledge from science, technology, engineering, and mathematics to design their projects [24]. For example, when the students doing a design project, they might utilize fundamental science knowledge, technological research, robotic engineering, and math measurement or calculation skills to help them finish the design. The research also indicates that employing the multidisciplinary approach enhances students' overall comprehension of STEM subjects and problem-solving competency [24]. The implication of this study for educators is that when designing a project-based STEM assessment for students, they can integrate the content of four subjects into an integrated unit that will promote students' comprehensive thinking in STEM design and application skills. The second implication is that, depending on the educational system in immigrant-orient children's home countries, they may arrive with varying levels of prior STEM knowledge. This group of students will be able to manipulate their own project at their own pace using the integrated STEM project approach, which will guide their design at their appropriate level. In this case, teachers will be able to differentiate their instruction to accommodate the diverse demands of immigrant students with different STEM background knowledge.

Furthermore, there also study stresses that integrated project-based learning contributes to students' STEM learning by connecting them with the real world, optimizing the classroom time, fostering deeper learning, and introducing students to technology [25]. According to the study, project-based STEM learning will help students keep up with the rapid advancement of technology in society by using the iPad in the classroom [25]. It also differentiates STEM guidance to meet each student's needs by tailoring the lesson material to their cognitive abilities. The takeaway from this article is that teachers can utilize integrated project-based STEM software to differentiate their teaching in the classroom. A good example is sometimes during the classroom work period, some students finish their tasks earlier than others and they are wandering around the classroom. In this situation, teachers can assign them to work on the iPad if they want to do the extension assignment or do more research on STEM topics. Other examples are the immigrant-orient children who might not be familiar with the natural world or technology industry in the new countries because they just come here and do not have many chances to explore the real world. Teachers can use the integrated project-based learning approach to acquaint this group of students to the ecology, weather, or geometrical characteristics by using the iPad Apps. According to the paper, the integrated project-based STEM learning approach helps students continually draw connections between different subjects and their prior knowledge, which strengthens their overall STEM learning [25]. The iPad integrated curriculum fills in the knowledge gaps for teachers who are unfamiliar with the cultural backgrounds of immigrant children and supports whole child STEM education.

For the teachers who are not familiar with immigrant children's background knowledge, the iPad integrated program fills in the teaching gaps for the whole child STEM education. Gerard et al. explain in their research that STEM vocabularies tend to be more like academic language for the students and they tend to spend more time mastering these words [26]. However, computers play an important role in supporting students in formulating their scientific languages by providing integrated revisions for their scientific explanations [26]. Research also notes that in recent years, there is a positive relationship between students' access to computers and students' scientific academic performance [27]. The research affirms that immigrant families have more difficulties to afford electronic devices for their children than the average native families [27]. This issue can be resolved by classroom teachers collaborating with the school's computer teacher to develop a curriculum that will allow students to use software to promote their STEM learning and mastery of scientific languages. For instance, some Massachusetts school districts provide each student with a Chromebook and give them a set period of time to use software like Lexia and Scratch to learn lexicon and computer coding every day. Additionally, teachers allow students to access their assigned computers in their free choice time, which makes the school curriculum and teaching more equitable for those immigrant children whose families have financial difficulties to provide them with a computer. At the same time, teachers can also advocate for this group of children by collaborating with some neighborhood non-profit organizations like YMCA to ensure these children of immigrants have equal opportunities to use the computer as their local peers.

4. Conclusion

In order to improve the engagement of STEM learning for the students of immigrants in the K-6 setting, this study addresses parental engagement, linguistic and culturally responsive teaching, and project-based integrated STEM learning to develop classroom teaching strategies. First and foremost, reading and literature are essential components of STEM learning comprehension for students. Parents with an immigrant background play a crucial role in assisting their children's acquisition of STEM languages in their home languages. To further promote STEM learning at home, teachers can communicate the STEM themes of the current unit learning and offer parents guidance to borrow books in their children's home languages that correspond to the content area. This strategy will be incredibly beneficial for parents who are more fluent in their home languages than in English since they will be better equipped to support their kids' STEM learning and comprehension across multiple

languages. Additionally, it is imperative for classroom teachers to develop the home-school connection throughout the academic year by conducting regular family contacts. Students spend a significant amount of time at home, so parents may have valuable observations on their children's STEM learning that can be used for designing the whole child's STEM curriculum. Teachers will be able to acquire the hidden information about children's learning from parents through conversation, especially for those immigrant-oriented students who may have a different home environment than their local counterparts. By establishing strong parent-teacher relationships, teachers would be able to share teaching strategies and plans with parents so that they can set up a consistent STEM learning environment for their children.

Secondly, because the local STEM network can reflect students' identities and encourage students' involvement in STEM learning, schools can connect with local STEM institutes and welcome them to be a part of the school STEM curriculum through this community-based learning approach. To apply this method, teachers may invite local STEM professionals to volunteer as guest speakers and share their views on everyday work for the students. Collaborating with local STEM businesses in the community to host open houses or arrange field trips is another way for schools to increase students' interest in STEM education. The students' home languages are also a significant aspect of their identity, particularly for those who are new to the country. It is essential that classroom teachers recognize that this group of students may encounter language barriers when trying to obtain the same academic content as their peers. Teachers could support these students in their STEM learning by developing a growth mindset in order to overcome these challenges by encouraging them to employ translanguaging abilities and providing equitable access to lesson content. Applying Culturally Responsive Teaching (CRT) in students' STEM learning also benefits children in both understanding their own cultures and connecting STEM learning with real-world practice. Engaging children in community STEM activities or talking with local STEM experts empowers students to discover their community cultures and the actual practices of the STEM industry.

Lastly, it has been shown that creating a cross subjects STEM curriculum for students has a positive outcome in deepening and broadening their comprehension of each subject. By completing an integrated subjects STEM project, students will be able to use multiple subjects to solve a problem and the approach will enhance their metacognitive skills. More importantly, the integrated strategy allows students to work at their own pace in solving a STEM program so that it meets the individual student's developmental level, especially for students who come from diverse cultural backgrounds. Students of immigrants will especially benefit from the integrated STEM approach because cooperating technology like iPad to teach other STEM subjects in the classroom will support teachers to fill in their knowledge gap about children who come from different cultural backgrounds and connect them in local STEM learning.

Besides the above findings, there are some limitations in this study. The review only focuses on developing classroom teaching strategies from three perspectives to support children of immigrants in STEM education: parental engagement, linguistic and culturally responsive teaching, and project-based integrated STEM learning. However, there are still more strategies in the different educational areas that can be developed to support children in their STEM learning like teachers' STEM teaching training, students' motivation, and social-emotional perspectives.

For future studies, researchers can develop a longitudinal study to record the observations of classroom teachers applying these strategies and analyze their advantages and disadvantages of them. Despite various existing studies only focusing on language teaching strategies for immigrant children in a k-6 setting, this study fills the research gap in providing STEM teaching guidance for this group of students.

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