Beckman, P.A. (2023). Diversity experience index informs sense of belonging. *RELIEVE*, *29*(1), art. M3. http://doi.org/10.30827/relieve.v29i1.27081

Revista ELectrónica de Investigación y EValuación Educativa

RELIEVE

ISSN: 1134-4032

e-Journal of Educational Research, Assessment and Evaluation

# Diversity experience index informs sense of belonging

***El índice de experiencia de diversidad informa el sentido de pertenencia***

***O índice de experiência de diversidade informa o sentido de pertença***

***通过多样化实验指数来展示归属感***

**مؤشر تجربة التنوع يعلم الشعور بالانتماء**

**Beckman, Paul A.**

San Francisco State University, California, United States.

**Abstract**

This research project was executed to demonstrate a new approach to increasing Sense of Belonging of individuals to groups to which they belong. The foundation of the approach lies in the application of concepts from a branch of math called Graph Theory. Graph Theory provides concepts and calculations that can be applied to understand the structures that arise when elements interact in a network. This project considers individual humans who interact when they come together to participate in some activity. In particular, we will apply this analytical methodology to UFM, Unaccompanied Foreign Minors, children who arrive without adult supervision or guidance from foreign countries to build a new life in their new country (in our case, Spain). One goal of the project is to increase the Sense of Belonging of these children to other children in the program with whom they do not share common characteristics (Age, Country of Origin, and Time Spent in Spain). We use the concept of "Diversity Experience Index", or DEI, that shows for any individual, the number of interactions they have had with other individuals with particular characteristics. A student's DEI values can then suggest future interactions in the program to achieve the goal of increasing their Sense of Belonging to other students in the program.

**Keywords:** unaccompanied foreign minors, sense of belonging, graph theory

**Resumen**

Este proyecto de investigación se desarrolló para demostrar un nuevo enfoque que permita aumentar el sentido de pertenencia de los individuos a los grupos en los que se integran. La base del enfoque radica en la aplicación de conceptos de una rama de las matemáticas llamada Teoría de Grafos. Esta teoría proporciona conceptos y cálculos que se pueden aplicar para comprender las estructuras que surgen cuando elementos o interactúan en una red; y en este caso se considera como elemento de análisis a las personas individualmente que interactúan cuando se reúnen para participar en alguna actividad. En particular, se aplica esta metodología de análisis a MENA o Menores Extranjeros No Acompañados, que son niños que llegan sin la supervisión o guía de un adulto desde países extranjeros para construir una nueva vida en su nuevo país, que en este caso es España. Uno de los objetivos es aumentar el Sentido de Pertenencia de estos niños hacia grupos en los que se integran otros niños del programa con los que no comparten características comunes (Edad, País de Origen y Tiempo de permanencia en España). Y como elemento de análisis se emplea el concepto de "Diversity Experience Index" o DEI, que muestra para cualquier individuo, el número de interacciones que ha tenido con otros individuos con características particulares. Los valores de este índice para un estudiante pueden sugerir interacciones futuras en el programa para lograr el objetivo de aumentar su Sentido de Pertenencia a otros estudiantes en el programa.

**Palabras clave:** menores extranjeros no acompañados, sentido de pertenencia, teoría de grafos

| **Received/*Recibido*** | Jan 10, 2023 | **Approved /*Aprobado*** | May 23, 2023 | **Published/*Publicado*** | Jun 29, 2023 |
|---|---|---|---|---|---|

***Corresponding author / Autor de contacto:*** Paul A. Beckman. College of Business; St. Francisco State University. Holloway Avenue 1600, San Francisco, California, 94132 (USA); correo-e: pbeckman@sfsu.edu

Beckman, P.A. (2023). Diversity experience index informs sense of belonging. *RELIEVE*, *29*(1), art. M3. http://doi.org/10.30827/relieve.v29i1.27081

**Resumo**

Este projeto de investigação foi desenvolvido para demonstrar uma nova abordagem que permita aumentar o sentido de pertença dos indivíduos aos grupos de que fazem parte. A base da abordagem reside na aplicação de conceitos de um ramo da matemática chamado Teoria dos Grafos. Esta teoria fornece conceitos e cálculos que podem ser aplicados para compreender as estruturas que surgem quando os elementos ou interagem numa rede; neste caso, as pessoas individuais que interagem quando se juntam para participar em alguma atividade são consideradas como elemento de análise. Em particular, esta metodologia de análise é aplicada a MENA ou Menores Estrangeiros Não Acompanhados, que são crianças que chegam sem supervisão ou orientação de um adulto vindos de países estrangeiros para construir uma nova vida no seu novo país, que, neste caso, é Espanha. Um dos objetivos é aumentar o Sentido de Pertença destas crianças a grupos em que estão integradas outras crianças do programa, com as quais não partilham características comuns (idade, país de origem e tempo de permanência em Espanha). E como elemento de análise, utiliza-se o conceito de "Diversity Experience Index" ou DEI, que mostra, para qualquer indivíduo, o número de interações que teve com outros indivíduos com características particulares. Os valores deste índice para um estudante podem sugerir futuras interações no programa para atingir o objetivo de aumentar o seu Sentido de Pertença a outros estudantes no programa.

**Palavras-chave:** Menores estrangeiros não acompanhados, sentido de pertença, teoria dos grafos

**摘要**

该研究旨在展示一种可以提高个人在所属集体中的归属感的新方法。该方法主要以数学理论分支--图论的概念应用为基础。图论的概念和计算可以用来理解网状关系中的事物和事物关系结构。在该研究中将因参与某活动而聚集在一起进行互动的个体作为研究对象。具体来说，我们将该分析方法用于无陪伴的外国未成年，也就是说没有成年人监护或指引的从外国来到新国家西班牙创建新生活的儿童。该研究的主要目的之一是提高儿童融入集体的归属感，这个集体也包含了该项目下不同特点（年龄、源国家、在西班牙的时间）的其他儿童。使用多样性实验指数进行分析，得到每个个体与其他有特质的个体之间的互动数量。分析得到的指数数值也可以为项目中的儿童提出未来互动建议，以此来达到提升他们归属感的目的。

**关键词:** 无陪伴的外国未成年、归属感、图论

**ملخص**

تم تطوير هذا المشروع البحثي لإظهار نهج جديد يزيد من شعور الأفراد بالانتماء إلى المجموعات التي يتم دمجهم فيها .يكمن أساس النهج في تطبيق مفاهيم من فرع الرياضيات يسمى Graph Theory. توفر هذه النظرية مفاهيم وحسابات يمكن تطبيقها لفهم الهياكل التي تنشأ عندما تتفاعل العناصر أو تتفاعل في شبكة, وفي هذه الحالة ,يعتبر الأفراد الذين يتفاعلون عندما يجتمعون للمشاركة في أحد عناصر التحليلنشاط .على وجه الخصوص, يتم تطبيق منهجية التحليل هذه على منطقة الشرق الأوسط وشمال إفريقيا أو القصر الأجانب غير المصحوبين ,وهم أطفال يصلون دون إشراف بالغ أو توجيه من دول أجنبية لبناء حياة جديدة في بلدهم الجديد ,وهو في هذه الحالة إسبانيا .يتمثل أحد الأهداف في زيادة الشعور بالانتماء لهؤلاء الأطفال تجاه المجموعات التي يندمج فيها أطفال البرنامج الآخرون الذين لا يتشاركون معهم خصائص مشتركة )العمر وبلد المنشأ ووقت البقاء في إسبانيا .(وكعنصر من عناصر التحليل, يتم استخدام مفهوم 'مؤشر والذي يوضح لأي فرد عدد ,التفاعلات التي أجراها مع أفراد آخرين بخصائص معينة .يمكن لقيم هذا الفهرس للطالب أن تقترح DEI تجربة التنوع 'أو تفاعلات مستقبلية في البرنامج لتحقيق هدف زيادة الشعور بالانتماء للطلاب الآخرين في البرنامج

**الكلمات الدالة :**القصر الأجانب غير المصحوبين بذويهم ,الشعور بالانتماء ,نظرية الرسم البياني

## Introduction

UFM (Unaccompanied Foreign Minors) are children who leave their home country to improve their lot in life. Reasons for leaving their homes can be economic, educational, or governmental. UFM who end up under the aegis of the country of Spain mostly come from Northern African countries such as Morocco, Ghana, and Nigeria. One of the goals of the Spanish government is to prepare each child so they can ultimately, when reaching the age of majority (18 years of age in Spain), become a productive member of Spanish society. This preparation includes education about various aspects of Spain, such as the Spanish language, culture, history, educational system, financial system, business, and economics.

Past research into UFM and processes related to their integration into Spanish society has resulted in knowledge of what factors are relevant to that process. Some of that research has found that interactions between children in the UFM program is relevant to various aspect of their learning. This prior research points to

the relevance of investigating the impact of connections of UFM children to each other.

With respect to collecting data about UFM, researchers found there are four dimensions in the Personal Learning Environments Questionnaire that are relevant in its application to UFM. Those four dimension are: self-concept of the learning process, planning and management of learning, use of resources and tools, and communication and social interaction [Martínez-Martínez, et al., 2019]. That research project found that one of the two most relevant of these factors was communication and social interaction, which suggests the relevance of examining connections between UFM and how those connections impact UFM integration and hence their learning.

Subsequent research using the PLE questionnaire [Tomé-Fernández, et al., 2020] found that there is a relationship between UFM age and the PLE dimension "communication and social interaction." These researchers found older UFM scored higher along this dimension, meaning that, likely due to their increased age and maturity, they had a greater ability to make and keep friends. This research project implies that "communication and social interaction" is important to the integration of UFM, therefore methods of measuring connections between UFM are likely to be relevant to UFM Sense of Belonging.

Researchers have also investigated the relationship between Personal Learning Environments, UFM, and level of education [Parra-González, et al., 2021]. These authors found that those UFM with an education level reported as "Professional Training" (the highest level of education) also reported the highest use of a PLE. Further, UFM at the lowest age level (8-10 years of age) reported the lowest level of use of a PLE. This suggests that interactions between UFM could be an important impacting factor on their learning, as the authors conclude "interaction and learning from peers is also a learned skill."

One of the ways that the goals of the UFM program can be achieved or promoted is to increase each child's Sense of Belonging to others in their group, as well as to the country of Spain. One way to increase an individual's Sense of Belonging to a group is to increase the number of interactions they have with members of that group [Bjorklund, et al., 2020, Brooms, 2020]. Psychology researchers have found that humans are more likely to accept and integrate with others with whom they share characteristics [Meeuwisse, et al., 2010]. Psychology researchers have also found that the more familiarity an individual gains with others who are *not* like them, the more likely they will accept and integrate with those different others [Strayhorn, 2009; Hussain and Jones, 2021]. We intend to test this second concept with UFM by monitoring and managing the interactions each child has with others in their group who are different than they are. To help guide our calculations, there is a long and well-founded history of mathematics that focuses on the interactions of elements in a network; this area of math is called "Graph Theory."

Graph Theory as a branch of mathematics has existed since 1735 when the Swiss mathematician Leonhard Euler solved the "Königsberg bridge problem," proving that there was no solution to traveling across each of the seven Königsberg river bridges without traversing any bridge twice. The field has been extended over the years to studying all facets of situations or environments wherein a network can be constructed that connects individual points with links. One common modern example is its constant use in determining how to send packets of information through the Internet, as the Internet is a network of computers connected by links.

Graph Theory is called "Social Network Analysis" when applied to situations where the nodes in the network are human beings or other living things. This is the domain in which we will apply Graph Theory and use it to better understand the network structures created when children come together to participate in specific organized activities. The particular classroom environment we will model is one in

which children (ages 8-18) leave their home countries in search of a better life in Spain. The children live together in housing provided by the Spanish government. They attend traditional classes appropriate to their age and prior education as well as extra-curricular activities intended to both educate and integrate the children.

One of Spain's goals for the educational process of the children is for them to gain a Sense of Belonging to other children who are like them *and* to other children who are *not* like them. This is a goal because it has been shown that people with greater Sense of Belonging have both better physiological (i.e., health) outcomes [Young, et al., 2004; Hale, et al., 2005] as well as higher performance in and adherence to the groups to which they belong [Shook and Clay, 2012]. It is our supposition that Graph Theory can be used to better understand and subsequently manage the interactions that children have when participating in organized activities provided through their educational process. Furthermore, that increased understanding of the children's past interactions can be applied in promoting future connections between children that will increase their Sense of Belonging to other children in their group.

There are many processes that could increase an individual's Sense of Belonging to or acceptance by a particular group, and increased interactions have been shown to be one of those processes [DellaPosta, 2018; Dyck and Pearson-Merkowitz, 2012]. It is this prior research that led us to apply Graph Theory to manage the interactions of children to increase their Sense of Belonging to other children.

Our application of Graph Theory led us to calculate for each child the measure called "Diversity Experience Index" [Beckman, 2018]. A DEI value is calculated for an individual by monitoring the interactions that individual has had with other individuals. If one knows a particular characteristic of everyone in the interacting group, one can calculate how many interactions each individual has had with others with that particular characteristic. For example, one characteristic of human individuals is sex (in general, "Male" or "Female"). If the appropriate data has been collected, it is possible to calculate for each person in a group the number of interactions (or even the total amount of time of interactions) they have had with both males and with females. Since humans generally accept and/or integrate more with those with whom they have had more interactions [Jellison, et al., 1984], knowledge and use of DEI values could be used to influence an individual's Sense of Belonging. For example, the Sense of Belonging of a new member to a group could be increased by having that new member interact more with an existing group member who has had more interactions with other group members who share one or more characteristic with the new member. For example, when considering the human characteristic of "sex", one could have a new female group member interact with male group members who have had more interactions with existing female group members.

## Method

We began our research project by constructing the data storage mechanism that would house the data for our calculations. Since Graph Theory is the foundational math that guides our comprehension of how to increase individuals' Sense of Belonging, it is important to understand the structure of the data store we will use and how that data store is based on entities and actions in the real world. Figure 1 (below) shows the Entity-Relationship Diagram (ERD) that describes the conceptual model for the database that underlies our Graph Theory calculations. An ER Diagram represents, at a conceptual level, things (called "entities") with named rectangles and interactions (called "relationships") with lines that connect the named rectangles.

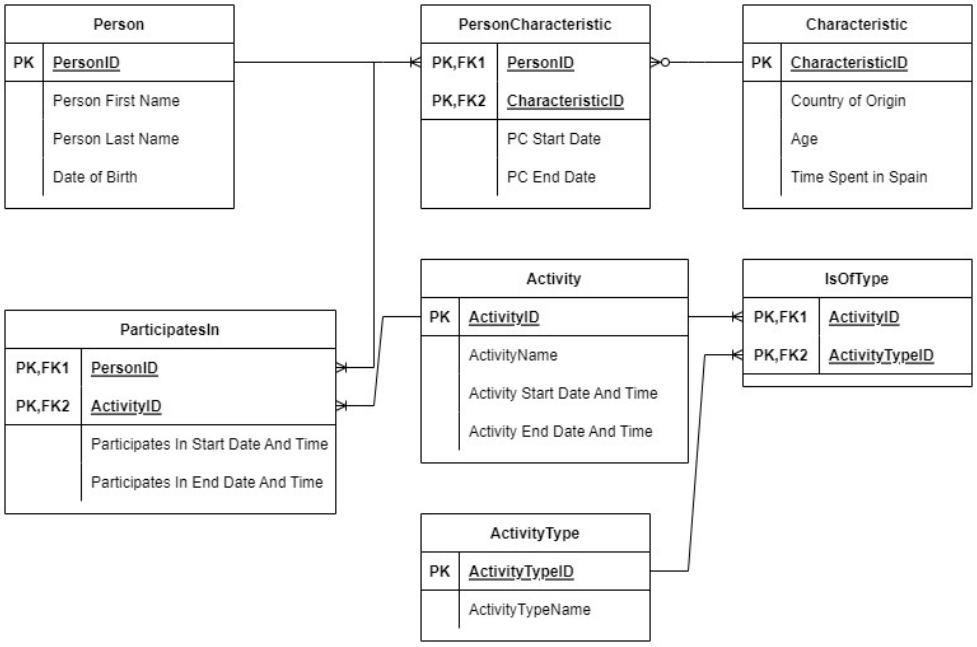
The most important entities in this diagram are those that represent the real-world elements of Person, Characteristic, and Activity. (The

entity type in the ER Diagram called "Activity Type" is used to store the generic description of each activity event that UFM can attend.) Each of those three entity types also has, in the ERD, lines of text that represent the traits of each entity type. For example, the lines of text in the rectangle labeled "Person" indicate those characteristics of a child that are relevant to our analysis, such as the person's unique identifier (PersonID), their First Name, Last Name, Date of Birth, Country of Origin, etc. Note that only the very basic attributes are indicated for each entity type; in the final version of the database there will be many more attribute types listed and stored. Also, if there is a "many-to-many" relationship between two entity types, it is common to create a new entity type (and eventually a table in the database) between the associated entity types. In our example, a Person (i.e., "UFM child") can have many characteristics (such as a Country of Origin, an Age, and an amount of Time Spent in Spain), while a Country of Origin can pertain to many Persons. This new entity type contains the "intersection" of the associations of each child to their many characteristics and the many children associated with each characteristic.

The lines of text inside the "Activity" rectangle represent the traits or attributes of the possible activities that children could attend. That is, each activity has a unique identifier (called the "Primary Key") named ActivityID. Each activity also has an activity name, an activity start date and time, and an activity end date and time. The relevant traits of the entity type "Characteristic" are those dimensions along which we wish to perform our analysis, and will be used in our Sense of Belonging calculations.

In our situation and application of Graph Theory, we will eventually perform computations that require binary values. Because of this requirement, we will forgo standard relational database design rules and create attributes for each value along each characteristics we wish to track. For example, we will track each child's Country of Origin. Finally, other Characteristics in we are interested are the age of each child (entered into age buckets of 8-10, 11-13, 14-16, and 17-18) and how long each child has been in Spain (with values of either 9 months or less or more than 9 months).

Figure 1. Entity-Relationship Diagram for Data Collection



To further describe our conceptual database model, the lines that connect the rectangles (i.e., entity types) in our database design represent the real-world interactions between entity types. For example, the line connecting the Person rectangle and the ParticipatesIn rectangle indicates that a child can attend many Activities but that child can only attend a specific activity one time. That "one-to-many" relationship is indicated by the "single-pronged" line at the Person end of the relationship and the "three-pronged" line at the ParticipatesIn end of the relationship.

Our conceptual data model shows from a data storage perspective how we intend to collect data. Before any child's data is entered into the system, characteristics of interest will be entered into the Characteristic table. If it becomes necessary to add more characteristics as the project progresses, those characteristics can be added to the existing values stored in the Characteristic table. Then as children arrive in Spain and are entered into the UFM program, a single row of data will be created for each one in the "Person" table. That row of data will include each child's unique attributes, such as First Name, Last Name, and Date of Birth. Next, the set of characteristics for each child (e.g., Country of Origin, Age, Time Spent in Spain) will be entered into the table created for the many-to-many relationship between Person and Characteristic. (Recall that a child will have many characteristics and a characteristic can be had by many children.) As activities are organized for the children to attend, the traits of that activity will be entered into the "Activity" table. Finally, when a child attends an activity, their participation will be entered into the table (shown on the ER Diagram as the ParticipatesIn entity type) created for the many-to-many relationship between Person and Activity. (Recall again that a child can attend many activities and an activity can have many children attend it.)

After the tables are populated with data, it will then be possible to determine which children attended which activities with which other children. This table of data is the foundation from which we will be able to determine which children interacted with which other children as well as the characteristics of each child and even the characteristics of the event that brought them together.

Because the project is in its early stages, no real-world data has been collected or entered into the database. However, it is possible to populate the database tables with randomly-generated values that will allow us to demonstrate and complete the calculation process showing the relationship between interactions between children. As our data will be randomly generated, it will not result in a dataset that follows the distribution of characteristics of children in the real world, and in particular, the characteristics of children in the UFM program. This will be evident in the final results of our calculations, but will not impact the description of the process by which we will perform those calculations. To begin this process, we generated random data for 25 children and gave them each a random set of characteristics of country of origin, age bucket, and length of time spent in Spain. We then generated a random set of 539 "connections" between children that simulated a set of activities which the children attended.

From this set of data records we can determine for each child which other children they interacted with; this is the basis for monitoring and managing interactions between children in the group. We can also see the characteristics of each child to determine if there is a relationship between interactions and the characteristics of each child. Since we are also able to see which activities brought children together, we could establish if there are particular characteristics of activities that impact the connections made by the children.

Finally, we can create a graphic, based on our data of each child's interactions with other children, that will show us how much experience each child has had with other children with characteristics that are similar or different; this graphic shows each child's DEI. For example, for a child who is between the ages of 11 and 13, from Morocco, and who has

spent more than 9 months in Spain, we can see how many interactions they have had with other children who share those same characteristics *and* how many interactions they have had with children who share *some* or *none* of those characteristics. These concepts are very important, as we expect children who have the same characteristics to naturally gain a Sense of Belonging to each other as they will be of a similar age (and thus more likely to share physical growth experiences), from the same country (and thus more likely to share the same first language and home country cultural experience), and have been in Spain a similar amount of time (and thus more likely to share similar levels of understanding of and education in the UFM program).

The graphic we will use to show these levels of interaction is called a Radar Diagram, and we will create one such graphic for each child. A Radar Diagram is useful for quickly and easily showing numeric values along many independent (or non-independent) characteristics, which is exactly what we need to see, as based on the description in the previous paragraph. For example, for the hypothetical student described above (who is between the ages of 11 and 13, from Morocco, and has spent more than 9 months in Spain), we first will be able to see the number of interactions they have had with other children who share their same characteristics (although this is not the focus of our research, as we believe that children who share characteristics are already more likely to gain a Sense of Belonging with each other purely because of those shared characteristics). More importantly, we will be able to see, for this same child, the number of interactions they have had with children *not* from Morocco, whose age is *not* between 11 and 13, and/or who have *not* spent more than 9 months in Spain. This knowledge will allow us to track changes over time in Sense of Belonging that each child has with others who are different than they are.

One example of how we could to use this knowledge is when a new child enters into the UFM program. We know that new child will generally increase their Sense of Belonging to other children in the program who share their own characteristics. What we wish to do is to have that child gain a Sense of Belonging to children already in the program who do *not* share their characteristics. We can increase that probability by having the new child attend activities with children who are different than they are (i.e., who do not share their characteristics), but who have more experience with children who do share the characteristics of that new child.

Given the description above and our set of randomly created data records, our calculations followed this general process:

1. For each activity, store the unique identifier of each child who attended.
2. Generate the set of (Person1ID, Person2ID) records for each activity to show which pairs of children were at the same activity.
3. For each set of (Person1ID, Person2ID) records, retrieve the characteristics of Person2 to show the characteristics of the people that Person1 has interacted with.
4. For each Person1ID, sum the number of interactions for each individual characteristic to show the total experience level each child with children possessing that characteristic.
5. Create a Radar Diagram for each child using as input the results from the previous calculation step.
6. Use the Radar Diagrams to find individual(s) most appropriate to interact in the future for some result beneficial to the individual or group [e.g., to increase an individual's Sense of Belonging to the group].

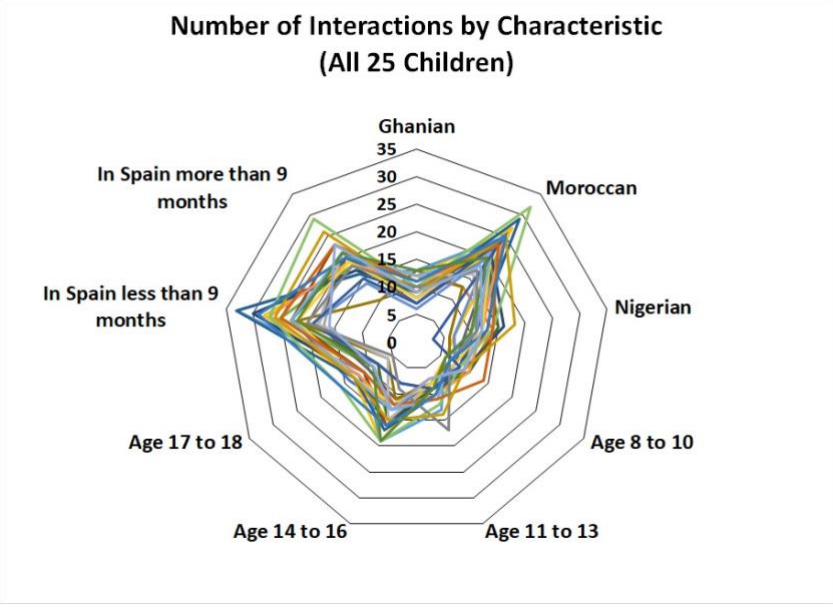
## Results and discussion

Figure 2 (below) shows the set of Radar Diagrams for all 25 simulated children in the

UFM program. This compilation of all Radar Diagrams is fairly unwieldy as it provides too much information in one image. However, a quick inspection of this figure shows, among other things, the results of the random assignment of characteristics to the 25 children. Each "polygon" inside the larger regular nonagon (nine-sided-polygon) represents the interaction values of one child. That is, the diagram shows for each child the number of interactions that child has had with children who had the characteristic value of that dimension. In this DEI calculation, each characteristic value is binary; for example, a child is from Ghana or is not from Ghana. This explains why so many children have many more interactions with other children from Morocco than they have interactions with children from Ghana: the random assignment of "Country of Origin" values to the 25 children resulted in many more children from Morocco than from Ghana. In fact, our random assignment of characteristic values table shows 6 children from Ghana, 13 children from Morocco, and 6 children from Nigeria. This random assignment of characteristics value to a child also shows that more children were assigned to "In Spain less than 9 months" than to "In Spain more than 9 months". A check of our random assignment of characteristic values table shows 14 children with the former value and 11 children with the latter value.

Similar to how this set of Radar Diagrams shows overall patterns in the composition and interactions of the individuals in the group, with real world data, it would show similar patterns. For example, if the situation under consideration were a corporation, Radar Diagrams based on our calculations could show interactions between members of different functional areas. If the corporation had data about the characteristics of its employees, it could also show which workers have had the most interactions with members of the opposite sex, workers who had the most interactions with handicapped co-workers, ex-military veterans, etc. Our DEI calculation and display process applies to any situation were people come together and knowledge of their characteristics is known. From that basic dataset, our results can be used to try to impact the individuals' Sense of Belonging to members of any group to which they belong.

Figure 2. Radar Diagrams for All Children

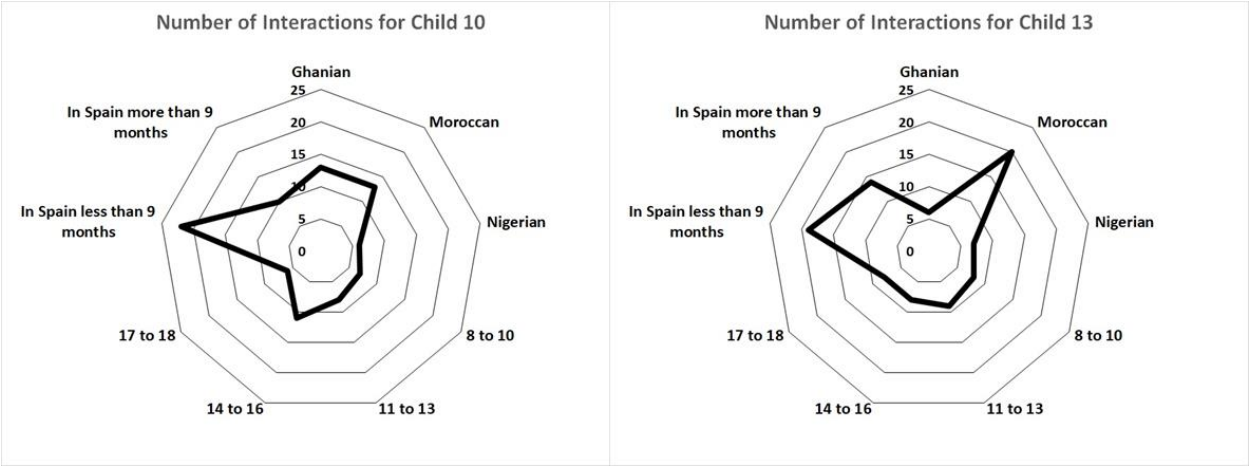


We can also use DEI diagrams to make actionable decisions that could impact students' Sense of Belonging. As one approach, we can dig more deeply into the DEI values, Figure 3 below shows example Radar Diagrams for two specific children. This avenue of investigation demonstrates what will guide the monitoring and managing of interactions between children to increase their Sense of Belonging. The two children we will examine more closely are:

**Child 10 with characteristics**: Moroccan, 8 to 10 years old, in Spain less than 9 months

**Child 13 with characteristics**: Ghanian, 11 to 13 years old, in Spain less than 9 months

Figure 3. Radar Diagrams for Two Children (#10 and #13)




With the information from these two images, we now have some guidance for this type of situation: a new child joins the UFM program. If that newly admitted child is from Ghana, age 15, and has been in Spain less than 9 months, we presume they will naturally increase their Sense of Belonging to other children who are like them: from Ghana, 15 years old, and in Spain less than 9 months. Our goal is to increase the new child's Sense of Belonging to children in the program who are *not* like them. Given the opportunity to pair the new child in activity with someone who is already in the UFM program, and seeing the Radar Diagrams of children 10 and 13, we would choose child 10 as child 10 has had more interactions with children LIKE the new child. Even though child 13 is from Ghana, child 10 has had more interactions with other children from Ghana. Neither child 10 nor 13 is in the same age group as the new child, but child 10 has had more interactions with children from the new child's age group. Finally, child 10 has had more interactions with children in the group who have been in Spain for less than 9 months. Our DEI Radar Diagrams show that, in this particular case, the new child is more likely to gain a Sense of Belonging to the whole group by interacting with child 10. Since the UFM managers have some control over the activities and interactions of the children in the program, it would make sense for them to facilitate interactions between the new child and child 10.

## Conclusions

This research project was executed to present an analytical methodology that applies Graph Theory concepts in support of increasing the Sense of Belonging of an individual to a group to which they belong. Calculations are shown related to network structures and how it might be possible then to monitor and even manage the connections

made between members of a group. That is, knowing which group members have had previous interactions with other group members while knowing relevant personal characteristics of all group members can be used as inputs to calculate a DEI ("Diversity Experience Index") value for each group member. DEI values shown on a Radar Diagram graphic can then guide decisions about future interactions that could increase particular group member's Sense of Belonging. This result would happen in situations, for example, where a new member joins the group and is paired in activities with existing group members who are not necessarily similar to the new member, but who have had many interactions with existing group members who are similar to the new group member. There are likely many other applications of the DEI calculation and results that could be applied to better understand group dynamics, such as to see which individual group member has interacted the most with other group members with particular characteristics. DEI values could also be used to determine which activities are the most conducive to bringing together group members with particular characteristics.

The results of our analytical methodology could be applied to any situation wherein individuals come together to participate in an activity, break up, then come together in different configurations to participate in another activity. This general process occurs in numerous real-world situations, such as employees coming together to work on corporate projects, professional athletes coming together to participate in league-sanctioned games, or groups of investors coming together to invest in private ventures.

## References

Beckman, P. (25-27 July de 2018). *Measuring Workforce Diversity at the Individual Employee Level: Applying Graph Theory to Measure Individual Diversity Experience*. Thirteenth International Conference on Interdisciplinary Social Sciences, XIII Congreso Internacional de Ciencias Sociales Interdisciplinares University of Granada, Granada, Spain.

Bjorklund Jr, P., Daly, A. J., Ambrose, R. & Van Es, E. A. (2020). Connections and capacity: An exploration of preservice teachers' sense of belonging, social networks, and self-efficacy in three teacher education programs. *AERA Open*, *6*(1), 2332858420901496. http://doi.org/10.1177/2332858420901496

Brooms, D. R. (2020). Helping us think about ourselves: Black males' sense of belonging through connections and relationships with faculty in college. *International Journal of Qualitative Studies in Education*, *33*(9), 921-938. https://doi.org/10.1080/09518398.2019.1687956

DellaPosta, D. (2018). Gay acquaintanceship and attitudes toward homosexuality: A conservative test. *Socius*, *4*, 2378023118798959. https://doi.org/10.1177/2378023118798959

Dyck, J. J. & Pearson-Merkowitz, S. (2012). The conspiracy of silence: Context and voting on gay marriage ballot measures. *Political Research Quarterly*, *65*(4), 745-757. https://doi.org/10.1177/1065912911411102

Hale, C. J., Hannum, J. W. & Espelage, D. L. (2005). Social support and physical health: The importance of belonging. *Journal of American College Health*, *53*(6), 276-284. https://doi.org/10.3200/JACH.53.6.276-284

Hussain, M. & Jones, J. M. (2021). Discrimination, diversity, and sense of belonging: Experiences of students of color. *Journal of Diversity in Higher Education*, *14*(1), 63. https://doi.org/10.1037/dhe0000117

Jellison, J. A., Brooks, B. H. & Huck, A. M. (1984). Structuring small groups and music reinforcement to facilitate positive interactions and acceptance of severely handicapped students in the regular music classroom. *Journal of Research in Music Education*, *32*(4), 243-264. https://doi.org/10.2307/3344923

Martínez-Martínez, A., Olmos-Gómez, M. D. C., Tomé-Fernández, M. & Olmedo-Moreno, E. M. (2019). Analysis of psychometric properties and validation of the personal learning environments questionnaire (PLE) and social integration of unaccompanied foreign minors (MENA). *Sustainability*, *11*(10), 2903. https://doi.org/10.3390/su11102903

Meeuwisse, M., Severiens, S. E. & Born, M. P. (2010). Learning environment, interaction, sense of belonging and study success in ethnically diverse student groups. *Research in Higher Education*, *51*(6), 528-545. https://doi.org/10.1007/s11162-010-9168-1

Shook, N. J. & Clay, R. (2012). Interracial roommate relationships: A mechanism for promoting sense of belonging at university and academic performance. *Journal of Experimental Social Psychology*, *48*(5), 1168-1172. https://doi.org/10.1016/j.jesp.2012.05.005

Tomé-Fernández, M., García-Garnica, M., Martínez-Martínez, A. & Olmedo-Moreno, E. M. (2020). An analysis of personal learning environments and age-related psychosocial factors of unaccompanied foreign minors. *International Journal of Environmental Research and Public Health*, *17*(10), 3700. https://doi.org/10.3390/ijerph17103700

Parra-González, M. E., Parejo-Jiménez, N., Conde-Lacárcel, A. & Olmedo-Moreno, E. M. (2021). Relationship between the personal learning environment and the educational level of unaccompanied foreign minors. *International Journal of Intercultural Relations*, *80*, 17-26. https://doi.org/10.1016/j.ijintrel.2020.10.009

Strayhorn, T. L. (2009). Fittin'in: Do diverse interactions with peers affect sense of belonging for Black men at predominantly White institutions? *Journal of Student Affairs Research and Practice*, *45*(4), 953-979. https://doi.org/10.2202/1949-6605.2009

Young, A. F., Russell, A. & Powers, J. R. (2004). The sense of belonging to a neighbourhood: can it be measured and is it related to health and well-being in older women? *Social science & medicine*, 59(12), 2627-2637. https://doi.org/10.1016/j.socscimed.2004.05.001

**Authors / Autores**

**Beckman, Paul A.** (pbeckman@sfsu.edu) 0000-0002-3627-4746

Information Systems Department, College of Business, San Francisco State University.

Paul A. Beckman has a BS in Geology and Geophysics from the University of Minnesota-Minneapolis and an MS in Management with an emphasis in Information Management and Engineering with an emphasis in Human Factors from Purdue University-West. In addition to his teaching tasks and research on Information and Communication Technologies and their human and educational dimension, he has experience as a programmer and analyst at Hewlett-Packard, an academic researcher at San Francisco State University, and a research staff member at the Institute for Defense Analyses.

**R**evista **EL**ectrónica de **I**nvestigación y **EV**aluación **E**ducativa

***E-Journal of Educational Research, Assessment and Evaluation***

[ISSN: 1134-4032]