May 2023

Determining English and Spanish Equity in Children's Engagement With Ignite by Hatch™

Report written by
Alexandra Post Miller, MA, MEd
Vice President of Research and Content, Hatch Early Learning

Statistical analysis by
Richard G. Lambert, PhD, EdS
Director, Center for Educational Measurement and Evaluation at University of North Carolina at Charlotte

Executive Summary

Ignite by Hatch™ is a digital learning platform anchored in a child-facing app that delivers engaging learning experiences through a dynamic digital play environment. Built to promote growth and development across seven domains, Ignite supports children's progression from pre-foundational through early elementary skills.

There has been a great deal of research around the social and cognitive benefits of multilingualism (Agirdag, 2014; Barac et. al., 2014), specifically as it relates to child development in the early years (Peleman et. al., 2022). Additionally, in the United States, 75.7% of English-learner students speak Spanish as their home language (National Center for Education Statistics, 2022). These early experiences that promote inclusive and equitable practices are critically important to create positive classroom experiences to nurture the linguistic development of multilingual children for success in preschool and beyond (Romijn et. al., 2021; Salem et. al., 2020). With that in mind, Ignite was designed to help support these children, with experiences available for children in both English and Spanish.

To ensure that these experiences are performing as designed, research was done by a third-party psychometrician. The research compared the two groups: children who engaged with Ignite using the English-language setting and children who engaged with Ignite using the Spanish-language setting. Their performance in the games was examined after first matching children by overall ability. Then, using the Rasch modeling context, differential item functioning (DIF) scores were calculated for these experiences. Evidence of DIF can lead to further investigation of game content, game interpretation by the children, language and translation issues, and even potential game bias (Lambert, 2023).

Of the 238 games investigated across the seven domains of development and learning, the analyses demonstrated negligible DIF for 199 games (83.61%). The analyses revealed evidence of moderate DIF for 22 of the games (9.24%) and large DIF for 17 of the games (7.14%). The differences in initial pass rates between the English and Spanish versions were generally small across all domains. Of the 238 games, 139 (58.40%) exhibited a difference in pass rates between the English- and Spanish-language versions of less than 5 percentage points, and 212 (89.08%) exhibited a difference in pass rates of less than 10 percentage points. These results are generally favorable and indicate a relatively small number of games with DIF, or potential for bias by game language.

Third-Party Evaluation of Ignite English and Spanish Experience Equity

Incorporating children's home languages into early childhood contexts can contribute to children's learning experiences and language development (Sierens & Van Avermaet, 2013). Additionally, it is important not only to value the children's home languages but also to contribute to the multilingual development of children (Salem et. al, 2020). By offering Ignite experiences in both English and Spanish languages, children are able to practice developing skills in their home language to support strong development across all seven domains of learning.

This study sought to investigate whether there were performance differences between the children who engaged with Ignite using the English- or Spanish-language versions of the games. DIF methods and analyses were leveraged to examine any of these potential differences and address these issues by providing evidence that there were not any advantages for a particular subgroup of children. The rationale for leveraging DIF analyses is that they can separate performance differences on specific games from individual differences in child ability. For this study, the third-party psychometrician examined a focal group (children who engaged with Spanish-language games) to gather evidence to demonstrate that the games are fair to the members of that particular subgroup. The reference group is typically the majority group, which, in this case, is the children who engage with English-language games. The presumption based on previous research (Lambert, 2022) is that the games are generally fair for the children in the reference group.

SAMPLE

This study examined the full sample of children who used Ignite during the 2021–2022 calendar school year (n = 63,465). The sample contained essentially an equal percentage of male (50.47%) and female (49.58%) children. The sample contained children who engaged with the English-language (95.57%) and Spanish-language (4.43%) versions of the games. In the Social Studies domain, n = 58,652 for English and n = 2,712 for Spanish. In the Science & Technology domain, n = 54,538 for English and n = 2,533 for Spanish. In the Social–Emotional domain, n = 51,045 for English and n = 2,293 for Spanish. In the Language & Communication domain, n = 58,174 for English and n = 2,767 for Spanish. In the Physical domain, n = 56,046 for English and n = 2,660 for Spanish. In the Mathematics domain, n = 56,000 for English and n = 2,576 for Spanish. Finally, in the Literacy domain, n = 59,483 for English and n = 2,758 for Spanish.

METHODS

Using the Rasch modeling context, DIF analyses were done for Ignite games in Levels 1 through 5. First, the Rasch model was used according to the Winsteps software package (Version 4.6.2.1; Linacre, 2020) to estimate each game's difficulty

level. Then, a separate Rasch analysis was conducted for each of the games across all seven domains. Next, the differences between the estimated game difficulty for the English (reference group) groups and Spanish (focal group) groups were examined. This was done to test for any presence or magnitude of DIF. The DIF contrast statistic, the difference between the paired Rasch item difficulty estimates for each item, was calculated as the simple difference between the item difficulty estimates for the focal and reference groups (Lambert, 2023).

After these initial analyses, Rasch–Welch *t* tests were done to evaluate the statistical significance. These tests are used to evaluate a null hypothesis that the DIF contrast value is zero against an alternative hypothesis that the DIF contrast is not zero. In addition to these analyses, the Mantel–Haenszel χ^2 statistics were used to determine any evidence of potential DIF. These tests examine a null hypothesis of no DIF by producing a probability of obtaining differences between the focal and reference groups as large as or larger than those obtained, given that there is no DIF. The groups are ranked by matching abilities, and their relative performance on each item is measured. Overall ability estimates for each respondent are then estimated based on the total scores on that measure. An alpha level of .05 was then used for all comparisons.

In addition to statistical significance testing, the difference in item difficulty estimates between the focal (children engaging in Spanish-language games) and reference (children engaging in English-language games) groups was used. Given the sensitivity of both the Rasch–Welch *t* test and the Mantel–Haenszel χ^2 to small differences, this is especially important with large sample-size studies in which statistical significance is easy to obtain even when the observed differences do not have practical implications. This magnitude of DIF contrast was determined using the criteria set forth by Zwick et. al. (1999). In their work, it was determined that if both the *t* and χ^2 statistics were statistically significant, and the magnitude of the DIF contrast was less than 0.43, the DIF magnitude was considered negligible. If both the *t* and χ^2 statistics were statistically significant, and the magnitude of the DIF contrast was greater than or equal to 0.43 and less than 0.64, the DIF magnitude was considered intermediate. If both the *t* and χ^2 statistics were statistically significant, and the magnitude of the DIF contrast was greater than 0.64, the DIF magnitude was considered large. Using these methodologies, results for the seven domains of learning in Ignite can be found in the following section.

RESULTS

Strong Initial Evidence of Equity in Ignite Experiences Across English and Spanish

The purpose of this study was to investigate whether or not Ignite Level 1–5 experiences equitably support children who use the product in English and Spanish. Prior research has supported the validity and reliability of Ignite experiences (Luce & Lambert, 2022), and when used to fidelity (30 minutes per week, per child, on average), children progress within Ignite to reach kindergarten readiness (Lambert, 2020; Lambert, 2021). Kindergarten-readiness skills are aligned to Level 4 in Ignite, which is

why this study went through Level 5. The following results highlight the findings and provide validation that, of the 238 games investigated, the analyses demonstrated negligible DIF for 199 games (83.61%). These results are generally favorable and indicate a relatively small number of games with DIF, or potential for bias by game language. The complete third-party report with detailed findings can be found here on the University of North Carolina at Charlotte's technical report website from the Center for Educational Measurement and Evaluation.

Social Studies Domain

The analyses indicated negligible DIF for 15 of the 18 games (83.33%), moderate DIF for one game (5.56%), and large DIF for two games (11.11%). The one game with moderate DIF, game 198, had an initial pass rate of 5.06% in English and 1.70% in Spanish, for a difference of 3.36 percentage points. The two games with large DIF, games 16 and 30, were very difficult and had very small pass rates (passing rates < 0.40%). These games demonstrated very small differences in pass rates between the English and Spanish versions.

Science & Technology Domain

The analyses indicated negligible DIF for 19 of the 20 games (95.00%), moderate DIF for one game (5.00%), and large DIF for none of the games (0.00%). The one game with moderate DIF, game 53, had an initial pass rate of 14.30% in English and 5.53% in Spanish, for a difference of 8.77 percentage points. These games demonstrated very small differences in pass rates between the English and Spanish versions.

Social–Emotional Domain

The analyses indicated negligible DIF for 25 of the 26 games (96.15%), moderate DIF for none of the games (0.00%), and large DIF for only one of the games (3.85%). The one game with large DIF, game 276, had an initial pass rate of 90.45% in English and 76.19% in Spanish, for a difference of 14.26 percentage points. These games demonstrated very small differences in pass rates between the English and Spanish versions.

Language & Communication Domain

The analyses indicated negligible DIF for 28 of the 31 games (90.32%), moderate DIF for two of the games (6.45%), and large DIF for only one of the games (3.23%). The first game that showed moderate DIF, game 35, had an initial pass rate in English of 7.76% and 2.49% in Spanish, for a difference of 5.27 percentage points. The second game that showed moderate DIF, game 159, had an initial pass rate in English of 3.27% and 0.83% in Spanish, for a difference of 2.44 percentage points. The one game with large DIF, game 28, had an initial pass rate of 5.77% in English and 4.26% in Spanish, for a difference of 1.51 percentage points. These games demonstrated very small differences in pass rates between the English and Spanish versions.

Physical Domain

The analyses indicated negligible DIF for 11 of the 16 games (68.75%), moderate DIF for five of the games (31.25%), and large DIF for none of the games (0.00%). The five games that showed moderate DIF, games 17, 114, 32, 196, and 199, showed differences in initial pass rates that ranged from as little as 0.30 percentage points (game 17) to as high as 6.34 percentage points (game 114). These games demonstrated very small differences in pass rates between the English and Spanish versions.

Mathematics Domain

The analyses indicated negligible DIF for 56 of the 64 games (87.50%), moderate DIF for four of the games (6.25%), and large DIF for four of the games (6.25%). The four games that showed moderate DIF, games 184, 104, 141, and 235, showed differences in initial pass rates that ranged from as little as 0.24 percentage points (game 235) to as high as 8.92 percentage points (game 184). The four games that showed large DIF, games 110, 129, 143, and 182, showed differences in initial pass rates that ranged from as little as 0.72 percentage points (game 182) to as high as 8.42 percentage points (game 110). These games demonstrated very small differences in pass rates between the English and Spanish versions.

Literacy Domain

The analyses indicated negligible DIF for 45 of the 63 games (71.43%), moderate DIF for nine of the games (14.29%), and large DIF for nine of the games (14.29%). Therefore, the analyses detected DIF within a substantially higher percentage of the Literacy games than in any other domain games. The nine games that showed moderate DIF, games 19, 82, 39, 102, 253, 52, 73, 103 and 146, showed differences in initial pass rates that ranged from as little as 0.82 percentage points (game 103) to as high as 6.67 percentage points (game 19). The nine games that showed large DIF, games 71, 248, 59,13, 46, 23, 49, 109, and 85, showed differences in initial pass rates that ranged from as little as 0.19 percentage points (game 85) to as high as 12.33 percentage points (game 248). These games demonstrated small differences in pass rates between the English and Spanish versions.

Conclusion

The findings of this study present a strong case that Ignite experiences offer equitable support for children, whether or not they use the product in English or in Spanish. This third-party research study examined the full sample of children who used Ignite during the 2021–2022 calendar school year (n = 63,465) and across Levels 1 through 5, using statistical analyses to prove that Ignite can help children reach kindergarten-readiness levels by leveraging the English- or Spanish-language experiences.

The results of this study are favorable, indicating only a small percentage of

games with DIF, or potential for bias by game language. The games in which DIF was detected will be investigated, particularly those in which large DIF was detected, as these results may indicate structural issues that favor English-speaking children or issues with the language translation within the games. Particular attention should be paid to the games within the Literacy domain, where the analyses identified a higher percentage of games with moderate or large DIF.

Future research will be needed to reexamine these updated experiences to improve equitable outcomes. Additionally, future research will be done to investigate the entire product beyond Levels 1 through 5—to include Level 6, Level 7, and Level 8—to ensure that the full set of Ignite experiences are showing equitable outcomes for children, whether they use the product in English or in Spanish.

References

Agirdag, O. (2014). The long-term effects of bilingualism on children of immigration: Student bilingualism and future earnings. *International Journal of Bilingual Education and Bilingualism, 17*(4), 449–464. https://doi.org/10.1080/13670050.2013.816264

Barac, R., Bialystok, E., Castro, D. C., & Sanchez, M. (2014). The cognitive development of young dual language learners: A critical review. *Early Childhood Research Quarterly, 29*(4), 699–714. doi:10.1016/j.ecresq.2014.02.003

Lambert, R. (2020). *Formative evaluation of the Hatch games for young children*. Charlotte, NC: UNC Charlotte Center for Educational Measurement and Evaluation.

Lambert, R. (2021). *Formative evaluation of the Ignite games for young children from Hatch Early Learning*. Charlotte, NC: UNC Charlotte Center for Educational Measurement and Evaluation.

Lambert, R. (2022). *Formative evaluation of the Ignite games for young children from Hatch Early Learning* (Report No. CEMETR-2022-06). Charlotte, NC: UNC Charlotte Center for Educational Measurement and Evaluation.

Lambert, R. (2023). *Differences in performance between children using the English and Spanish versions of the Ignite by Hatch™ educational gaming system.* Charlotte, NC: UNC Charlotte Center for Educational Measurement and Evaluation.

Linacre, J. M. (2020). Winsteps (Version 4.6.2.1) [Computer software]. https://winsteps.com

Luce, H. E., & Lambert, R. G. (2022). Providing validity evidence for Ignite by Hatch: A digital game-based learning experience for preschool children. In C. Lane (Ed.), *Handbook of research on acquiring 21st century literacy skills through game-based learning* (pp. 731–749). Hershey, PA: IGI Global. doi:10.4018/978-1-7998-7271-9.ch037

National Center for Education Statistics. (2022). *English learners in public schools*. U.S. Department of Education, Institute of Education Sciences. https://nces.ed.gov/programs/coe/indicator/cgf

Peleman, B., Van Der Wildt, A., & Vandenbroeck, M. (2022). *Home language use with children, dialogue with multilingual parents and professional development in ECEC*. Early Childhood Research Quarterly, *61*, 70–80.

Romijn, B. R., Slot, P. L., & Leseman, P. P. (2021). *Increasing teachers' intercultural competences in teacher preparation programs and through professional development: A review*. Teaching and Teacher Education, *98*, 1–15. https://doi.org/10. 1016/j.tate.2020.103236

Salem, T., Braband, J., & Lengyel, D. (2020). *Parental cooperation in early childhood education in Germany—bridging language barriers in multilingual settings.* In C. Kirsch, & J. Duarte (Eds.), Multilingual approaches for teaching and learning. From acknowledging to capitalising on multilingualism in European mainstream education (pp. 168–185). Routledge.

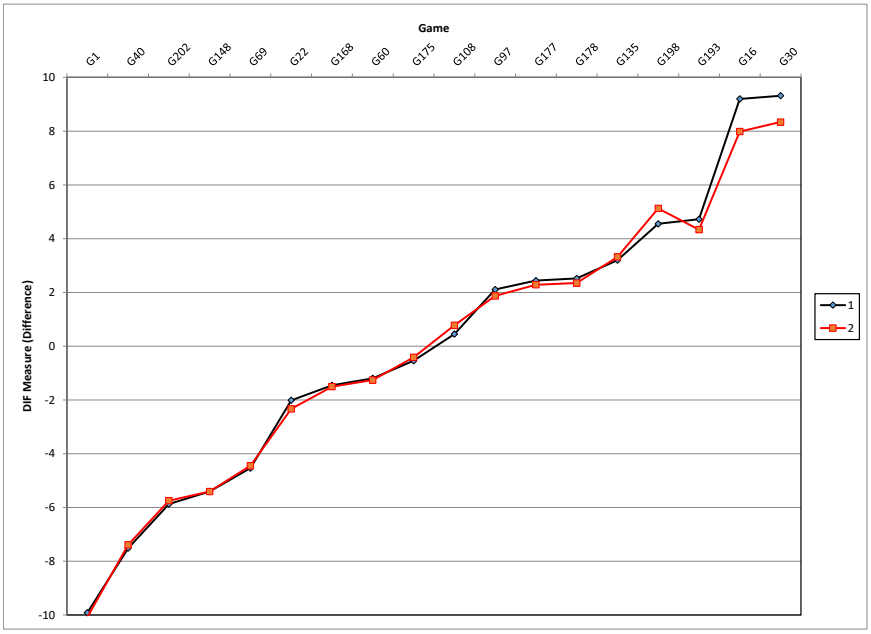
Sierens, S., & Van Avermaet, P. (2013*)*. Language diversity in education: Evolving from multilingual education to functional multilingual learning. In D. Little, C. Leung, & P. Van Avermaet (Eds.), *Managing diversity in education: Languages, policies, pedagogies* (pp. 204–222). Blue Ridge Summit: Multilingual Matters.

Zwick, R., Thayer, D. T., & Lewis, C. (1999). An empirical Bayes approach to Mantel-Haenszel DIF analysis. *Journal of Educational Measurement, 36*(1), 1–28. https://www.jstor.org/stable/1435320

Appendix

Figure 1

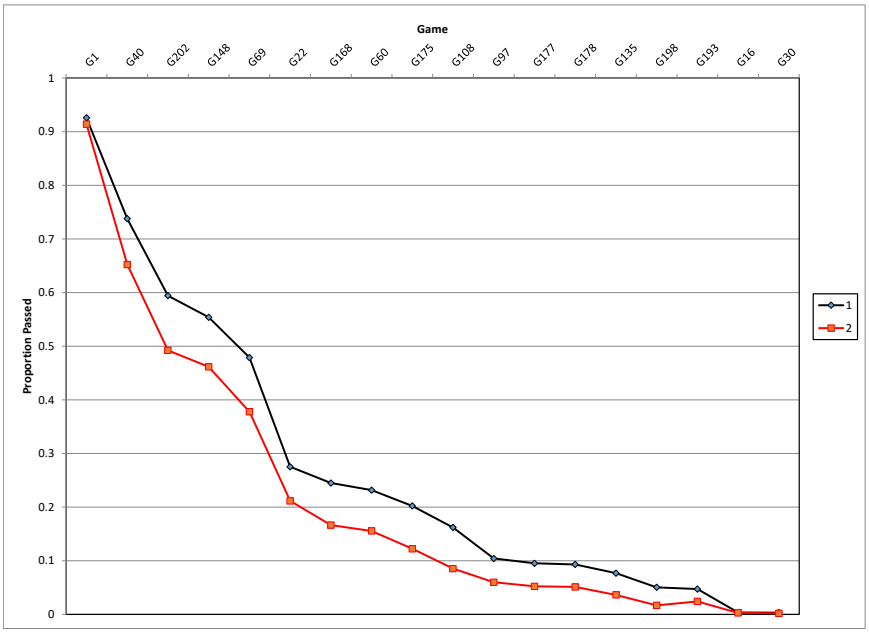
Differential Item Functioning (DIF) Results: Social Studies (1 = English, 2 = Spanish)



Note. Figure 1 contains the game difficulty estimates for each game in the Social Studies domain by language. Figure 1 displays the DIF results by highlighting the differences in game difficulty. The two lines on this graph are very similar, indicating how close most of the English and Spanish games are in difficulty level.

Figure 2

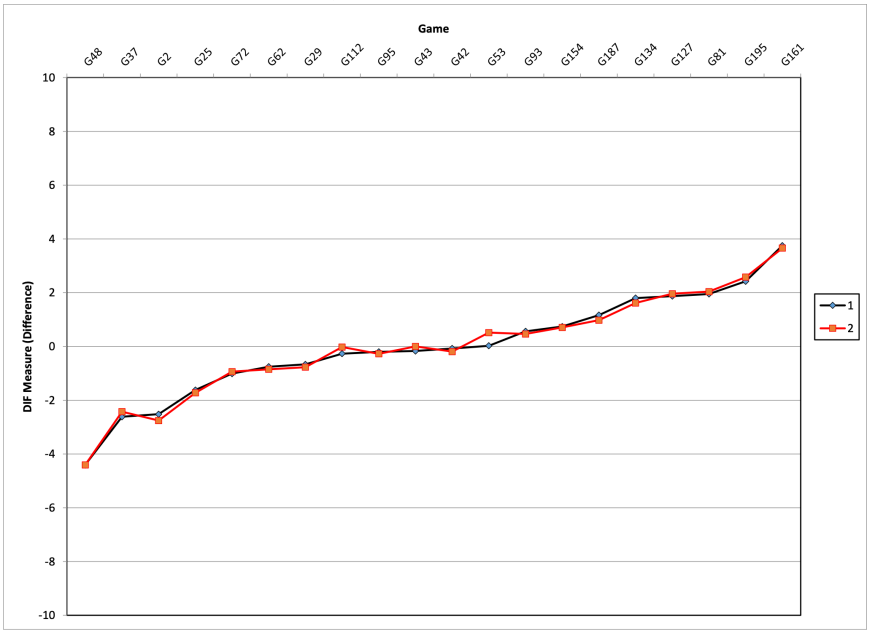
Pass Rates: Social Studies (1 = English, 2 = Spanish)



Note. Figure 2 displays the differences in initial pass rates by language. The initial pass rates were higher for the English versions for every game. However, the differences in initial pass rates between the English and Spanish versions were generally small across the Social Studies domain.

Figure 3

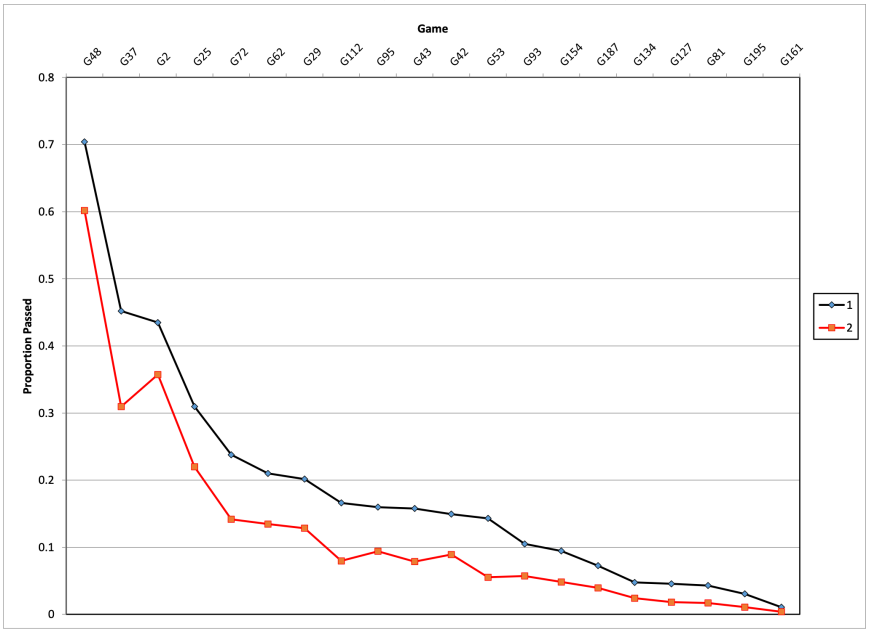
Differential Item Functioning (DIF) Results: Science & Technology (1 = English, 2 = Spanish)



Note. Figure 3 displays the DIF results by highlighting the differences in game difficulty. The two lines on this graph are very similar, indicating how close most of the English and Spanish games are in difficulty level.

Figure 4

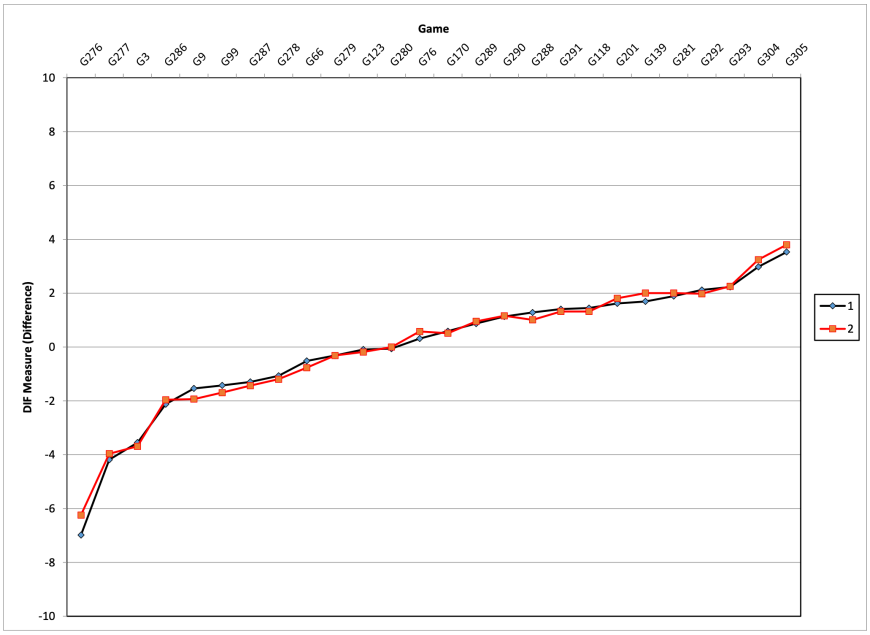
Pass Rates: Science & Technology (1 = English, 2 = Spanish)



Note. Figure 4 displays the differences in initial pass rates by language. The differences in initial pass rates between the English and Spanish versions were generally small. Eight of the 20 games (40.00%) exhibited a difference in pass rates of less than 5 percentage points. Eighteen of the 20 games (90.00%) exhibited a difference in pass rates of less than 10 percentage points.

Figure 5

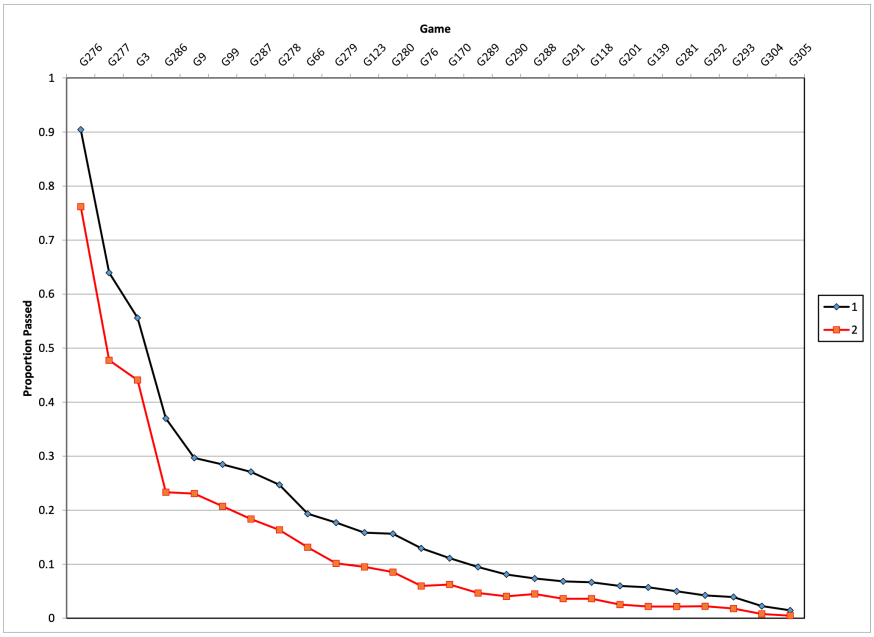
Differential Item Functioning (DIF) Results: Social–Emotional (1 = English, 2 = Spanish)



Note. Figure 5 contains the game difficulty estimates for each game in the Social–Emotional domain by language. Figure 5 displays the DIF results by highlighting the differences in game difficulty. The two lines on this graph are very similar, indicating how close most of the English and Spanish games are in difficulty level.

Figure 6

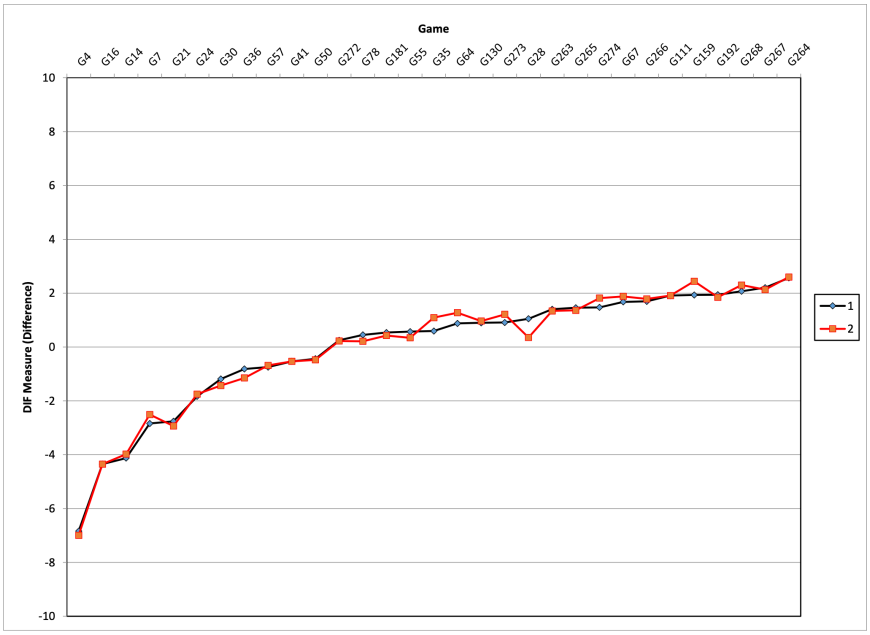
Pass Rates: Social–Emotional (1 = English, 2 = Spanish)



Note. Figure 6 displays the differences in initial pass rates by language. Again, the initial pass rates were higher for the English versions for every game. However, the differences in initial pass rates between the English and Spanish versions were generally small across the Social–Emotional domain. Of the 26 games, 13 (50.00%) exhibited a difference in pass rates of less than 5 percentage points, and 22 (84.62%) exhibited a difference in pass rates of less than 10 percentage points.

Figure 7

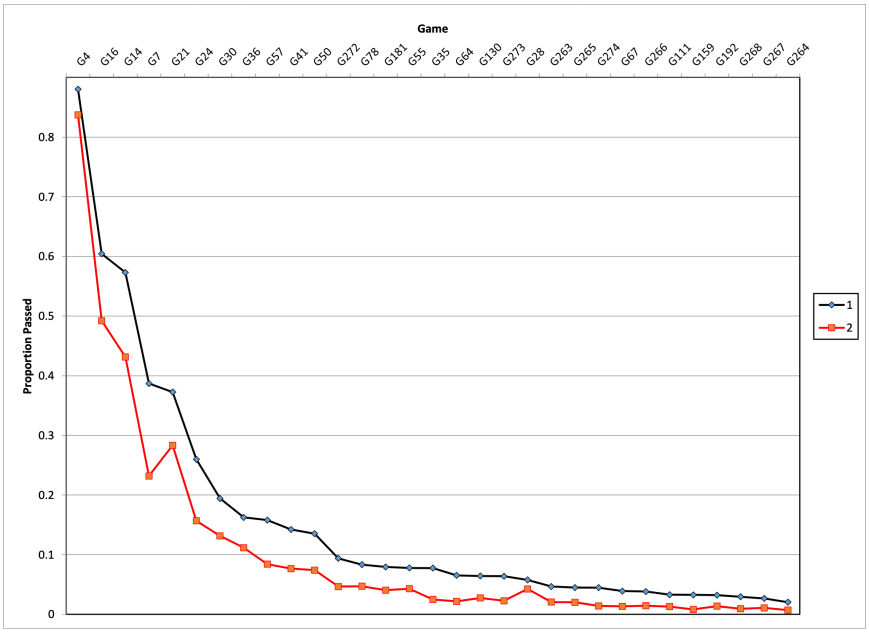
Differential Item Functioning (DIF) Results: Language & Communication (1 = English, 2 = Spanish)



Note. Figure 7 contains the game difficulty estimates for each game in the Language & Communication domain by English and Spanish. Figure 7 displays the DIF results by highlighting the differences in game difficulty. The two lines on this graph are very similar, indicating how close most of the English and Spanish games are in difficulty level.

Figure 8

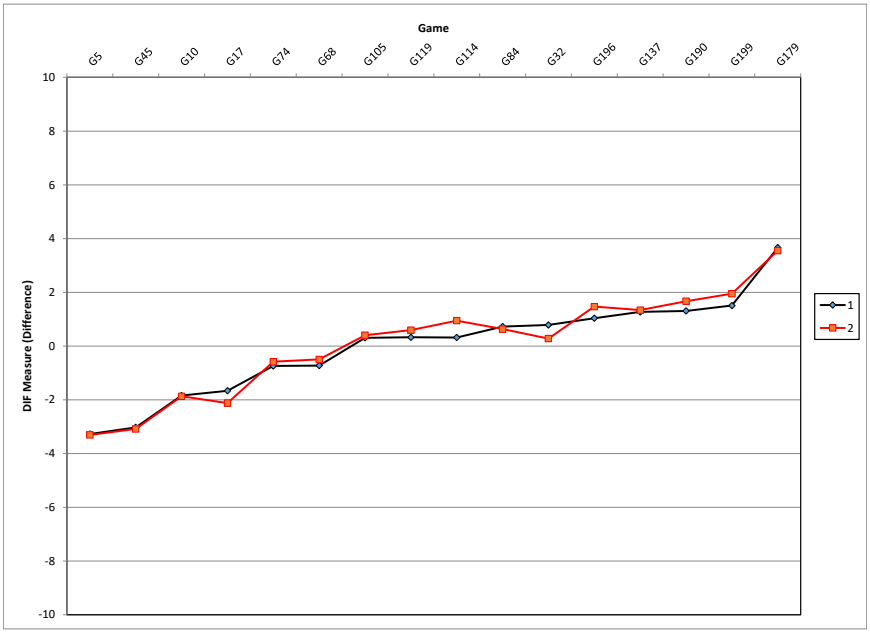
Pass Rates: Language & Communication (1 = English, 2 = Spanish)



Note. Figure 8 displays the differences in initial pass rates by language. Again, the initial pass rates were higher for the English versions for every game. However, the differences in initial pass rates between the English and Spanish versions were generally small across the Language & Communication domain. Of the 31 games, 20 (64.52%) exhibited a difference in pass rates of less than 5 percentage points, and 27 (87.10%) exhibited a difference in pass rates of less than 10 percentage points.

Figure 9

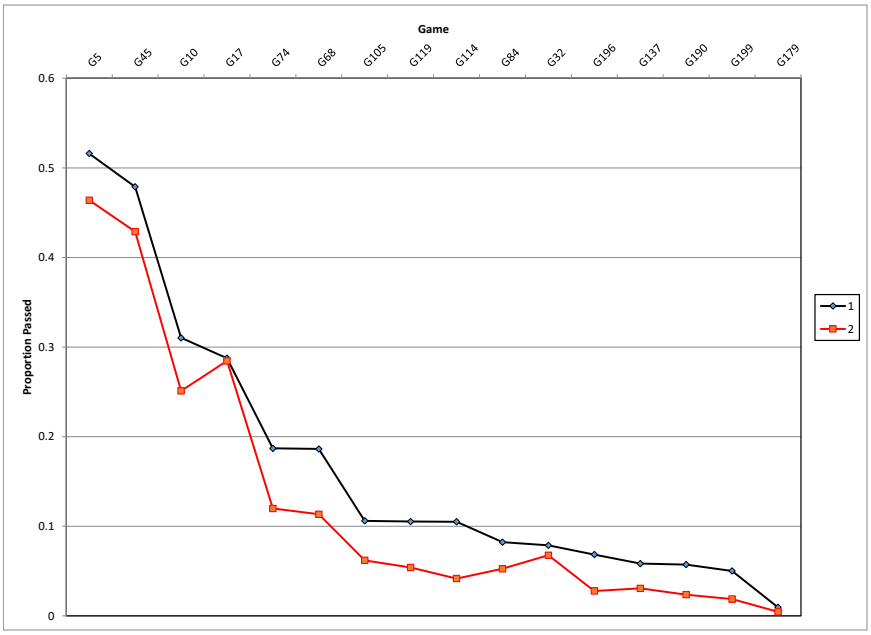
Differential Item Functioning (DIF) Results: Physical (1 = English, 2 = Spanish)



Note. Figure 9 contains the game difficulty estimates for each game in the Physical domain by English and Spanish. Figure 9 displays the DIF results by highlighting the differences in game difficulty. The two lines on this graph are very similar, indicating how close most of the English and Spanish games are in difficulty level.

Figure 10

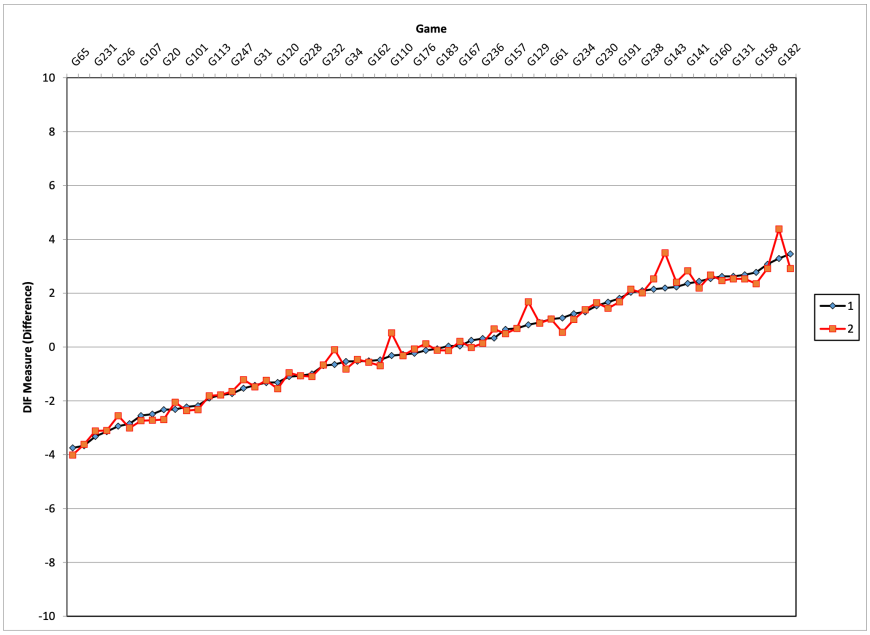
Pass Rates: Physical (1 = English, 2 = Spanish)



Note. Figure 10 displays the differences in initial pass rates by language. Again, the initial pass rates were higher for the English versions for every game. However, the differences in initial pass rates between the English and Spanish versions were generally small across the Physical domain. Of the 16 games, 12 (75.00%) exhibited a difference in pass rates of less than 5 percentage points. All 16 games (100.00%) exhibited a difference in pass rates of less than 10 percentage points.

Figure 11

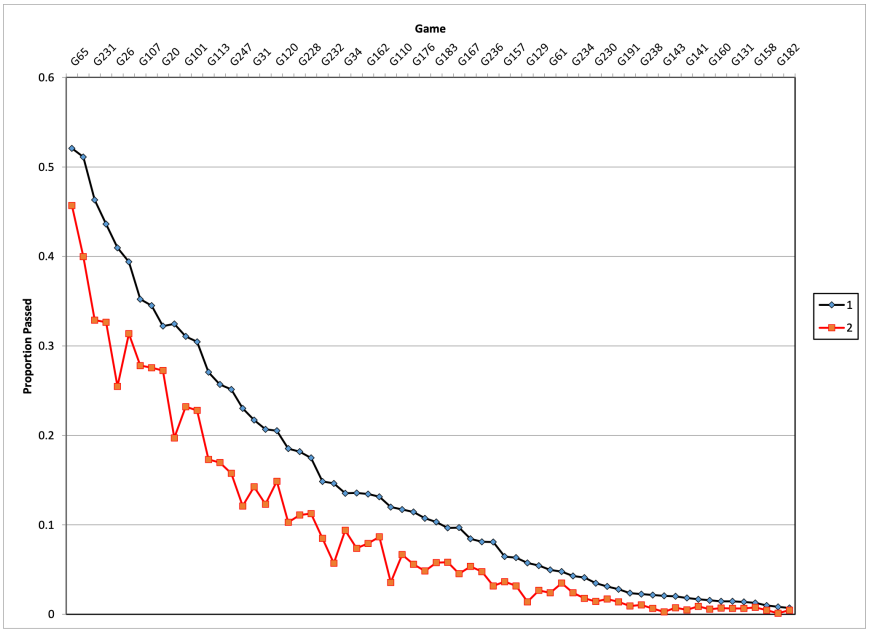
Differential Item Functioning (DIF) Results: Mathematics (1 = English, 2 = Spanish)



Note. Figure 11 contains the game difficulty estimates for each game in the Mathematics domain by English and Spanish. Figure 11 displays the DIF results by highlighting the differences in game difficulty. The two lines on this graph are very similar, indicating how close most of the English and Spanish games are in difficulty level.

Figure 12

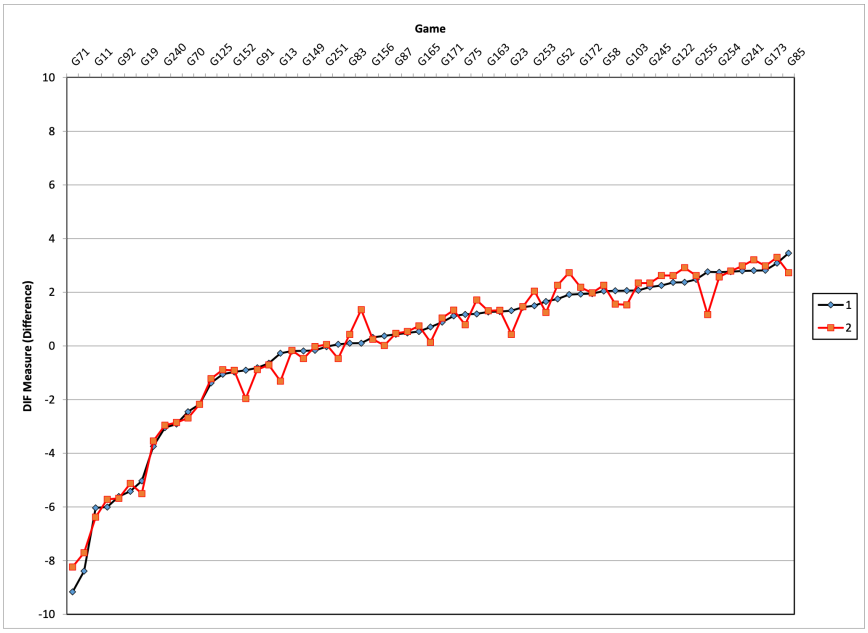
Pass Rates: Mathematics (1 = English, 2 = Spanish)



Note. Figure 12 displays the differences in initial pass rates by language. Again, the initial pass rates were higher for the English versions for every game. However, the differences in initial pass rates between the English and Spanish versions were generally small across the Mathematics domain. Of the 64 games, 34 (53.13%) exhibited a difference in pass rates of less than 5 percentage points, and 58 (90.63%) exhibited a difference in pass rates of less than 10 percentage points.

Figure 13

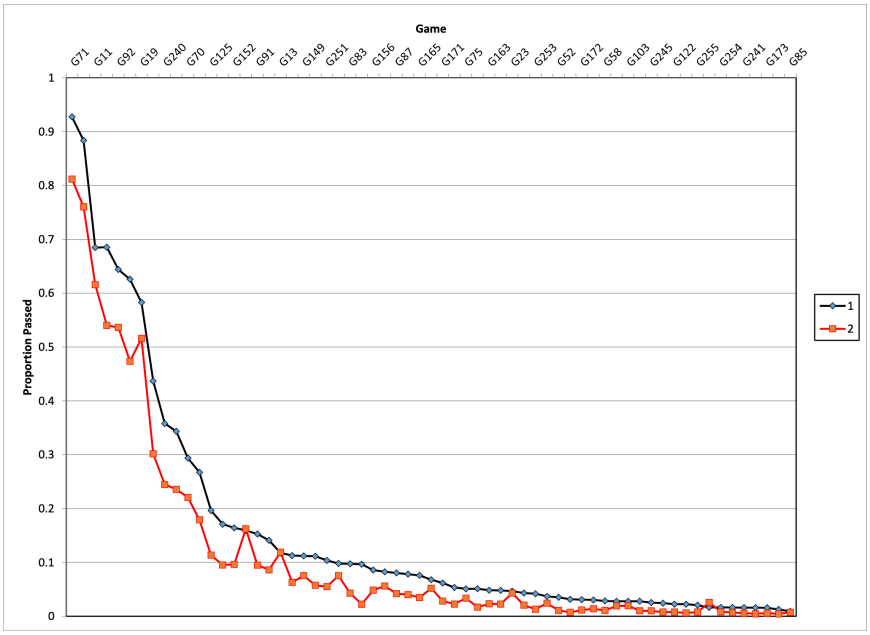
Differential Item Functioning (DIF) Results: Literacy (1 = English, 2 = Spanish)



Note. Figure 13 contains the game difficulty estimates for each game in the Literacy domain by English and Spanish. Figure 13 displays the DIF results by highlighting the differences in game difficulty. The two lines on this graph are very similar, indicating how close most of the English and Spanish games are in difficulty level.

Figure 14

Pass Rates: Literacy (1 = English, 2 = Spanish)



Note. Figure 14 displays the differences in initial pass rates by language. The initial pass rates were higher for most of the English versions of the games. However, the initial pass rates were almost identical for three of the games, which actually showed a slight advantage for the Spanish versions. The differences in initial pass rates between the English and Spanish versions were generally small across the Literacy domain. Of the 63 games, 43 (68.25%) exhibited a difference in pass rates of less than 5 percentage points, and 55 (87.30%) exhibited a difference in pass rates of less than 10 percentage points.