



Facilitating the Development of Advanced L2 Academic Writing

Adam Christopher

Atomi University

Reference Data:

Christopher, A. (2024). Second language self-concept and self-efficacy in Japan. In B. Lacy, R. P. Lege, & P. Ferguson (Eds.), *Growth Mindset in Language Education*. JALT. <https://doi.org/10.37546/JALTPCP2023-12>

This paper focuses on first-year university students' perceptions of their L2 self-concept and self-efficacy in English academic writing. Data were collected at a Japanese university through 16 learning journals. Student L2 self-concept included positive, mixed, and negative self-concept descriptions, as well as stories of change. Grades, the learning environment, and social comparisons were all included in students' descriptions. Students' self-efficacy in their academic writing reflected a developmental stage. Students who reported higher levels of positive, emerging self-efficacy described feelings of ease when writing in academic settings. Students who reported low self-efficacy stated that academic writing was unfamiliar to them and that they required more guidance and feedback. Negative L2 self-concept appeared to be more associated with low self-efficacy in academic writing. The findings suggest that positive L2 self-concept can aid in the development of self-efficacy in English academic writing.

本論では、英語のアカデミック・ライティングする日本の大学 1 年生の L2 自己概念と自己効力感についての認識を調査した。16 の学習日誌を通じ 収集されたデータによると、学生の L2 の自己概念には、肯定的、混合的、否定的な説明と、変化の記述が見られ、そのすべてに成績、学習環境、社会的比較が含まれていた。アカデミック・ライティングに対する学生の自己効力感、発達段階を反映し、より高いレベルの肯定的な自己効力感を報告した学生は、学術的な環境で文章を書くのが楽だと述べた。一方、自己効力感が低いと報告した学生は、アカデミック・ライティングには馴染みがなく、より多くの指導とフィードバックが必要であると述べた。L2 の否定的な自己概念は、アカデミック・ライティングにおける自己効力感の低さと関連しているようだ。結果は、肯定的な L2 自己概念が、英語での論文作成における自己効力感の発達に役立つことを示唆している。

Self-concept refers to an individual's belief in their competency and affect in a specific domain. It is characterised by its dynamic nature, complexity, and contextual dependence and is influenced by past and present experiences (Roiha & Mantyla, 2019; Mercer, 2014; Iwaniec, 2014). Self-efficacy refers to an individual's confidence in their own capability to successfully complete a specific task, such as writing a research paper in English as an L2 (Bandura, 2001). An individual's self-perceived ability to write in an L2 serves as a reliable measure of their writing proficiency (Golparvar & Khafi, 2021; Teng et al., 2018).

Researchers (e.g. Mercer, 2014; Teng et al., 2018) emphasised the significance of assessing and improving the self-concept and self-efficacy of language learners and writers in an academic setting. In order to achieve success in academic writing, one must possess robust self-efficacy and a good judgment of one's capabilities to organize and execute the courses of action (Bandura, 2001; Teng et al., 2018). Prior to formulating instructional strategies aimed at enhancing students' confidence in their L2 academic writing and skills, it is crucial to get a thorough understanding of these challenges. There is a scarcity of research in the field of L2 studies that focuses on the potential relationship between individuals' beliefs in their ability to write academically in L2 and their perception of themselves in that language.

Research has predominantly concentrated on examining L2 writing self-efficacy and L2 self-concept as distinct constructs (Iwaniec, 2014; Chao et al., 2019). Based on this research, self-efficacy and self-concept are distinct yet interrelated factors in L2 acquisition (Chao et al., 2019; Iwaniec, 2014). Other studies have demonstrated that L2 writing self-efficacy is influenced by linguistic factors (Golparvar & Khafi, 2021; Teng et al., 2018), and that L2 self-concept is associated with writing abilities. Conducting additional qualitative studies in various circumstances has the potential to enhance our understanding of L2 self-concept beyond what is currently known.

Prior research on writing self-efficacy in L2 acquisition has predominantly used quantitative methodologies. In contrast, research on L2 self-concept has integrated both



quantitative and qualitative methodologies, with a predominant emphasis on individual case studies in the qualitative domain. Qualitative research can provide insight into subtle distinctions, levels of intricacy, and unique variations.

Literature Review

An individual's self-perception is mostly influenced by their experiences and reactions to their environment and situations (Seaton et al. ,2015). The internal/external frame of reference paradigm pointed out that certain occurrences might occur either within individuals or outside of them. Comparing one's individual self-concept with that of others is an essential component of the internal frame of reference (Marsh et al. ,2019).

Individuals who are proficient in a second language experience both stable and dynamic aspects of their self-concept (Roiha & Mantyla ,2019). L2 learners could be categorised as (a) individuals with highly positive perceptions of their English abilities, (b) individuals whose perceptions of their English abilities varied significantly, and (c) individuals whose perceptions of their English abilities were negative (Roiha & Mantyla, 2019). In addition, an L2 student may experience a sense of incongruity between their views and their self-perception (Mercer, 2017). The presence of positive experiences in learning and using an L2, both in and out of the classroom, appears to be associated with the development of a positive self-perception in that language (Mercer, 2014).

Self-efficacy had a higher predictive accuracy for outcomes compared to actual skill level (Bandura ,2001). The level of specificity of self-efficacy enhanced one's ability to accurately predict outcomes (Bong & Clark ,1999). The development of self-efficacy is influenced by four key factors: verbal persuasion, emotional states, observational learning, and personal achievements. This constitutes a component of Bandura's 2001 triadic reciprocity theory. According to this theory, conduct, internal variables, and external factors are all interconnected. Learners who possess self-efficacy have the ability to analyse, monitor, and modify their own actions (Zimmerman & Schunk ,2012),

Some L2 research has investigated self-efficacy and self-concept simultaneously. Self-concept is cultivated through social interactions and exhibits a robust association with self-assurance in one's speaking proficiency (Iwaniec ,2014). In another study, quantitative analysis was used to examine the relationship between self-efficacy and self-perception among L2 learners. It was shown that self-efficacy and self-concept in the target language were reliable indicators of L2 proficiency (Chao et al. 2019). These prior studies suggested a relationship between a person's self-perception in their native language and their confidence in their abilities linked to an L2, as well as their proficiency in the L2.

Methodology

The aim of this study was to investigate first-year university students' perceptions of their L2 self-concept and self-efficacy in English academic writing. The research methodology used can be classified as a group-level case study due to its focus on the perspectives of a specific student cohort in a specific context regarding a particular issue. With this aim in mind, the following research questions were proposed:

- RQ1 What kinds of variability may be observed in the students' descriptions of their L2 self-concept?
- RQ2 What forms of variation are there in the students' self-efficacy views?
- RQ3 How do the various categories in the students' descriptions of their L2 self-concept and their self-efficacy manifest collectively in the dataset?

Participants and Data Collection

This investigation was carried out at a Japanese university's faculty of science. The purpose of the English writing course was to equip students with the necessary skills to effectively engage in demanding academic writing tasks. This was achieved by honing their proficiency in crafting formal, scholarly, and iterative essays. The course incorporated collaborative work in small cohorts, independent editing exercises, and peer feedback sessions. The participants of this study were 16 EFL students enrolled in freshman English courses, all of whom were between the ages of 18 and 20. The participants had studied English in Japan for at least ten years. The average TOEIC test score of the participants ranged from 405-600 points. Data were collected through 16 single-entry learning journals that were collected at the beginning of the English-language course as an assignment. The journals were based on open-ended questions, which required the students to engage in self-reflection as follows:

- What is your background as an English learner?
- What are your strengths as an English writer?
- What types of challenges do you typically face when writing academic English?
- What do you think about your academic writing performance?

The journal entries, serving as an autobiography, offered valuable insight into the learner's self-perception, as well as the emotional and motivational aspects that influence their learning. Regardless of the methodology used, self-reporting is a crucial



Christopher: *Second Language Self-Concept and Self-Efficacy in Japan*

component of research pertaining to personal matters (Mercer, 2014). The journals, varying in length from one to two pages, were compiled and uploaded to the course's Learning Management System (LMS). This was the first voluntary assignment of the English course, which was taught by the author of this study. Instead of receiving a grade based on their assignment, the whole class received full marks, regardless of their agreement to participate in the study. Hence, students' reflections and participation weren't derived from their ambition to achieve a good grade. The author explicitly stated that participation was entirely optional, and choosing not to join would not impact their final grades. Additionally, they were assured that the participants' anonymity would be safeguarded during the entire process. All participants were required to indicate their willingness to participate in the research. This was carried out in compliance with the university's established protocol for obtaining informed consent. A total of 16 students (80 % of the class) expressed their agreement with the utilisation of their learning journals in this study.

Data Analysis

The data were analysed using qualitative content analysis (Mayring, 2000; Hsieh & Shannon, 2005). This four-step approach provides a methodical and accurate depiction of the subject matter by organising it into categories. The initial phase involved the author and an expert in Applied Linguistics conducting independent reviews of the journals. This enhanced their understanding of the fundamental principles provided in the texts, which they then discussed among themselves. The journals, containing detailed records of the students' previous experiences in learning L2, provided valuable understanding of the students' self-perception as L2 learners and their level of confidence in their future English academic writing skills. In the second phase, the author and his colleague reached an agreement on the coding criteria and implemented the data coding procedure. The second phase of the study was informed by theoretical frameworks, specifically the L2 self-concept (Mercer, 2011; Seaton, 2015), the L2 writing self-efficacy (Bandura, 1986), and the differentiation between self-concept and self-efficacy (Bong & Skaalvik, 2003).

There is a need to differentiate between self-concept and self-efficacy (Bong & Skaalvik, 2003). The expansion of "L2 self-concept descriptions" occurred when an individual elaborated on their English learning status in a broader manner, mostly emphasising the past. In the current study, this might be exemplified by statements like "I've always been good at English" or "It has always been easy for me to learn English". The aforementioned words clearly demonstrate the act of passing judgment

by the individual. Marsh et al. (2019) provided comparable comments and evaluations. In a broader sense, the narratives shared by the students regarding their L2 learning experiences were regarded as "external manifestations" of their self-perception in that particular language (Mercer, 2014; Walker, 2015). A wide spectrum of emotions and occurrences were considered during the categorisation process. The decision was made to categorise remarks according to students' perceived writing ability.

During the third phase, the author conducted a thorough analysis of the coded data from each learning journal. This analysis involved multiple iterations to uncover further variations and categories within the descriptions of L2 self-concept and self-efficacy beliefs. This phase also included the cross-tabulation analysis of how the defined categories under the concepts of L2 self-concept and self-efficacy in academic writing happened together in terms of frequency. Although less prevalent in qualitative research, this form of quantification can enhance qualitative findings and uncover trends at the group level in the data.

The fourth and final phase entailed the author engaging in comprehensive discussions with his colleague to reach conclusive interpretations. The goal was to improve the reliability of its findings by meticulously scrutinising and recording every stage of the analysis process. Theory triangulation was used by considering self-efficacy and self-concept when interpreting the data. Table 1 displays the criteria utilised alongside the corresponding extracts categorised according to each attribute.

Table 1
Criteria Utilised Alongside the Corresponding Categorised Extracts

Extracts	Code
<p>Extract 1:</p> <p>"I've always liked going to school to learn English. I've always had no trouble with English since I played computer games all the time. This has given me a strong foundation in both spoken and written communication."</p> <p>(student 1 journal entry)</p>	<ul style="list-style-type: none"> L2 self-concept descriptions apply to how individuals perceive themselves as English second language learners. These descriptions typically include a reflection on the past and an overall evaluation of oneself as a whole.



Christopher: *Second Language Self-Concept and Self-Efficacy in Japan*

Extracts	Code
<p>Extract 2:</p> <p>“I have faith in my writing skills. When writing academic papers, the rules for how to do it are much simpler than those of reflective assignments. Because of this, writing tends to take less time.”</p> <p>(student 5 journal entry)</p>	<ul style="list-style-type: none"> Self-efficacy refers to an individual's belief in their ability to effectively engage in academic writing in the English language. This belief can pertain to both current and future instances of academic writing. It encompasses the expression of confidence in one's capacity to successfully navigate the challenges associated with academic writing.

Results

L2 Self-Concept

Descriptions with Positive Connotations

The initial group comprised of predominantly positive L2 self-concept depictions and encounters (seven out of 16). Students commonly used the term “always” to describe a consistent and enduring sense of positivity self-concept as English learners, starting from their early years in elementary school.

Extract 3:

“I always liked English in school. Lots of English lessons from films, video games and the Internet, and not too much work at school.” (student 2 journal entry)

Extract 4:

“I have always felt that English is fun. I remember the foreign teachers who used to teach English at my school. They were friendly and kind. I learned a lot from them.” (student 3 journal entry)

The majority of the journal entries within this group primarily emphasized the straightforward, enjoyable, and motivating experience of studying English in an academic setting. In this group, English was regarded as a language that is used globally and is necessary for global academic investigations.

Change Indicating a Shift Towards More Positive Connotations

The second category comprised of L2 self-concept descriptions that depicted a shift towards a more positive trajectory (four out of 16). These narratives originated from students' negative experience and assessments as English learners during their early education, and then depicted a shift towards a more positive trajectory, typically occurring in upper secondary school or university.

Extract 5:

“I used to have a very negative view of English as a language and a school subject, but now I see it in a very different light. I got a new teacher when I started secondary school. She inspired me to really start learning and gave me the chance to do so. I believe I began to seriously study English. Now, I think I speak proper English well.” (student 8 journal entry)

Extract 6:

“The fact that we have English classes in our first year of college is amazing. This will help my language skills.” (student 9 journal entry)

Students in this group experienced a sense of inadequacy in their English skills during their early years in school due to difficulties in the classroom, receiving bad grades, and being compared to students who outperformed them in L2. Their improvements were related to several factors, such as a different educational environment, a new instructor, more challenging and pertinent language learning assignments, improved grades, and greater exposure to English in authentic contexts, including online discussions, games, and international travel.

Mixed Connotations

A discrepancy arose between previous encounters and the evaluations, both positive and negative, (three out of 16) in the third classification of L2 self-concept descriptions.

Extract 7:

“I should have learned English more than I did. English wasn't as hard as physics and math. I still think I'm good at English, but I think my speaking and writing

Christopher: *Second Language Self-Concept and Self-Efficacy in Japan*

badly are my weak points.” (student 12 journal entry)

Students in this group stated that although their enthusiasm for English had diminished since their school days, they remained intrigued by it due to its frequent application in their personal lives. They expressed greater assurance in their scientific expertise compared to their proficiency in the English language.

Descriptions of Change Indicating a Shift into More Negative Connotations.

The fourth category comprised of L2 self-concept descriptions that exhibited a transition towards a more pessimistic trajectory, predominantly occurring throughout upper secondary school or later in university (one out of 16).

Extract 8:

“I was good at English in elementary school, but I don’t know what happened in high school. I had a hard time with everything, but I worked hard. The grades were still the same. I have trouble with English at university. I feel a little scared when I speak English these days. I don’t think I’m very useful for group reports, because everything I do is wrong or not good enough.” (student 15 journal entry)

The student regarded English as his favorite subject, and he dedicated more time to studying it in his earlier years. However, he had an adverse impact as a result of various factors, including a shift in the educational environment, and self-evaluations that resulted in feelings of inadequacy in English.

Descriptions with Negative Connotations

The fifth category primarily comprised of negative L2 self-concept descriptions and experiences (one out of 16). This student used the term “never” in his self-description as an L2 learner.

Extract 9:

“I’ve never been very interested in English as a subject. I was interested in physics and mathematics. Outside of school, I never used English much. I read some things in English at the university. Not much has changed.” (student 16 journal entry)

The student expressed a greater sense of dissatisfaction with his English proficiency compared to other subjects, such as physics and mathematics. He expressed his lack of motivation, insufficient effort, and casual usage of English.

*Self-efficacy Views on L2 Academic Writing**Developing Self-efficacy: “I am capable of handling it.”*

This category included 11 out of 16 descriptions that conveyed a feeling of competence in dealing with academic writing.

Extract 10:

“I think I’m good at reading books. I like that academic books let me be myself. I can just state facts and draw conclusions from them.” (student 4 journal entry)

Extract 11:

“I hope that my writing is mostly free of mistakes, easy to read, and even fun. Most of the time, writing in math and physics is pretty easy. The main purpose of the rules is to help the writer explain equations and create figures in a way that is easy to understand.” (student 6 journal entry)

Low Self-efficacy: “I expect to have difficulties.”

This category comprised of two out of 16 descriptions that conveyed a feeling of inadequacy in dealing with English academic writing and a strong inclination to acquire further exposure, criticism, or instruction on academic writing.

Extract 12:

“I don’t think I’m very good at writing scientific papers in English. I’ve only done it once.” (student 15 journal entry)

Extract 13:

“I don’t have much experience writing English essays. It’s hard for me to be exact and use citations when I’m writing essays. We haven’t been taught how to cite.” (student 16 journal entry)



Christopher: *Second Language Self-Concept and Self-Efficacy in Japan*

Balanced Reflections: “I am aware of my strengths and weaknesses.”

This category comprised three out of 16 descriptions that provided well-rounded reflections on the learner’s aptitudes and limitations in academic writing.

Extract 14:

“Aside from a few school essays, I haven’t written anything really important. I learned that I have a hard time with long, complicated words while writing those essays. I read science books, and the language I learn from them is definitely one of my strengths.” (student 12 journal entry)

Extract 15:

“As a writer, I use a variety of sentences and clear English, but I think my writing isn’t always as formal as it needs to be for school.” (student 14 journal entry)

The Relationship Between Self-perception and Writing Abilities in L2

Table 2 presents a detailed breakdown of the frequency of the identified categories in relation to self-efficacy in L2 academic writing and L2 self-concept descriptions. Among the students who demonstrated developing confidence in their academic writing abilities, most of them had a favourable perception of their L2 skills. Among those who expressed a lack of confidence in their academic writing abilities, most described themselves negatively in terms of their L2 proficiency. When examining these categories, it was shown that good descriptions of L2 self-concept were commonly associated with developing self-efficacy for academic writing.

Table 2

Cross Tabulation of L2 Self-concept and Self-efficacy Data

N = 16 learning journals	Positive L2 self-concept connotation n = 7	Change toward positive L2 self-concept connotation n = 4	Mixed L2 self-concept connota- tions n = 3	Change toward negative. L2 self-concept connota- tions n = 1	Negative L2 self-concept connota- tions n = 1
Developing self-efficacy n = 11	7	4	3	1	1
Low self- efficacy n = 2	0	0	0	1	1
Balanced reflections n = 3	0	1	1	1	0

Conclusion

The researcher of this study investigated the qualitative differences in the conceptions of L2 self-concept and self-efficacy for L2 English academic writing among first-year university students in Japan. The findings provided insight into the intricate and diverse relationship between L2 self-concept and self-efficacy in academic writing. This aspect had not been previously investigated. Although intricate, these findings suggest that negative perceptions of one’s L2 self-concept may often coincide with low self-confidence in academic writing, whereas favourable perceptions of one’s L2 self-concept may aid in the development of self-confidence in academic writing. In the Japanese higher education context, addressing the variation in L2 academic writing is a complex task. This study proposes that teachers should examine and take into account the influence of L2 self-concept and self-efficacy when developing university writing courses. These courses may include a comprehensive focus on writing, customisable components, personalised feedback, reflection, and opportunities for learners to take control of their own learning.

One limitation of this study is that the data only included journals that were written

Christopher: *Second Language Self-Concept and Self-Efficacy in Japan*

once, which may only reflect the thoughts and experiences of the learners at the time the data were collected. Another constraint is the somewhat organised instructions for the content of the learning journals, which may have resulted in certain stories not being fully expressed. Moreover, the data were collected from a relatively uniform set of learners inside a defined context, which restricts the extent to which the findings may be applied to other contexts. Future investigations could adopt a mixed-methods approach to examine the relationship between L2 self-concept and self-efficacy in academic writing, as well as their impact on writing quality in different higher education settings. Additional research is necessary to comprehend the self-concept of L2 and its connection to other well-considered factors, such as the self-efficacy of L2 writing proposed by Mercer (2014).

Bio Data

Dr. Adam Christopher is an Associate Professor at Faculty of Letters, Atomi University. His research interests include Foreign Language Acquisition, Applied Linguistics, CALL, Curriculum Development, Intercultural Communication, and Comparative Culture.

References

- Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, 52(1), 1–26. <https://doi.org/10.1146/annurev.psych.52.1.1>
- Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. *NursingPlus Open*, 2, 8–14. <https://doi.org/10.1016/j.npls.2016.01.001>
- Bong, M., & Clark, R. (1999). Comparison between self-concept and self-efficacy in academic motivation research. *Educational Psychologist*, 34(3), 139–153. <https://doi.org/10.1207/s15326985ep3403>
- Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: How different are they really? *Educational Psychology Review*, 15(1), 1–40. <https://doi.org/10.1023/A:1021302408382>
- Chao, C. N. G., McInerney, D. M., & Bai, B. (2019). Self-efficacy and self-concept as predictors of language learning achievements in an Asian bilingual context. *Asia-Pacific Education Researcher*, 28(2), 139–147. <https://doi.org/10.1007/s40299-018-0420-3>
- Creswell, J. W. (2007). *Qualitative inquiry and research design. Choosing among five approaches*. Sage Publications. <https://revistapsicologia.org/public/formato/cuali2.pdf>
- Denzin, N. K. (2012). Triangulation 2.0. *Journal of Mixed Methods Research*, 6(2), 80–88. <https://doi.org/10.1177/1558689812437186>
- Golparvar, S. E., & Khafi, A. (2021). The role of L2 writing self-efficacy in integrated writing strategy use and performance. *Assessing Writing*, 47, 100504. <https://doi.org/10.1016/j.asw.2020.100504>
- Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15(9), 1277–1288. <https://doi.org/10.1177/1049732305276687>
- Iwaniec, J. (2014). Self-constructs in language learning: What is their role in self-regulation? In K. Csizer, & M. Magid (Eds.), *The impact of self-concept on language learning* (pp. 189–205). Multilingual Matters. <https://doi.org/10.21832/9781783092383-012>
- Marsh, H. W., Pekrun, R., Parker, P. D., Murayama, K., Guo, J., Dicke, T., & Arens, A. K. (2019). The murky distinction between self-concept and self-efficacy: Beware of lurking jingle-jangle fallacies. *Journal of Educational Psychology*, 111(2), 331–353. <https://doi.org/10.1037/edu0000281>
- Mayring, P. (2000). Qualitative content analysis. *FQS Forum: Qualitative Social Research*, 1(2). DOI: <https://doi.org/10.17169/fqs-1.2.1089>
- Mercer, S. (2011). Language learner self-concept: Complexity, continuity and change. *System*, 39(3), 335–346. <https://doi.org/10.1016/j.system.2011.07.006>
- Mercer, Sarah. “4 Re-imagining the Self as a Network of Relationships”. *The Impact of Self-Concept on Language Learning*, edited by Kata Csizér and Michael Magid, Bristol, Blue Ridge Summit: Multilingual Matters, 2014, pp. 51–70. <https://doi.org/10.21832/9781783092383-005>
- Mercer, S. (2017). Working with language learner histories from three perspectives: Teachers, learners and researchers. *Studies in Second Language Learning and Teaching*, 3(2), 161. <https://doi.org/10.14746/ssllt.2013.3.2.2>
- Roiha, A., & Mantyla, K. (2019). ‘It has given me this kind of courage’: The significance of CLIL in forming a positive target language self-concept. *International Journal of Bilingual Education and Bilingualism*, 1–17. <https://doi.org/10.1080/13670050.2019.1636761>, 0(0)
- Seaton, M., Marsh, H. W., Parker, P. D., Craven, R. G., & Yeung, A. S. (2015). The Reciprocal Effects Model Revisited: Extending Its Reach to Gifted Students Attending Academically Selective Schools. *Gifted Child Quarterly*, 59(3), 143–156. <https://doi.org/10.1177/0016986215583870>
- Teng, L. S., Sun, P. P., & Xu, L. (2018). Conceptualizing writing self-efficacy in English as a foreign language context: Scale validation through structural equation modeling. *Tesol Quarterly*, 52(4), 911–942. <https://doi.org/10.1002/tesq.432>
- Yin, R. (2003). *Case study research design and methods*. Sage Publications, Inc. <https://cmc.marmot.org/Record/b23142807>
- Zimmerman, B. J., & Schunk, D. H. (2012). Motivation, an essential dimension of self-regulated learning. In B. J. Zimmerman, & D. H. Schunk (Eds.), *Motivation and self-regulated learning, Theory, research and applications* (pp. 1–30).