Listenability Assessment for Language Learning Through the Quality of Experience Lens

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***Abstract*—The assessment of listenability, or the comprehensibility of spoken materials, is important for listening practice as it enables language learners to identify suitable learning materials. In this paper we present a new Listenability Framework using the Quality of Experience principles as a basis for developing an understanding of the listenability assessment process. The Listenability Framework promotes a holistic approach to the assessment of spoken materials, incorporating influencing factors derived from listening comprehension research and listenability assessment studies. We envision our framework as an aid in the development of automated assessment systems, as well as a means of examining existing systems for further development. We apply our framework in reviewing the current state of research on automated listenability assessment and identifying challenges and avenues for future work.**

***Index Terms*—listenability, spoken material assessment, language learning, quality of learning experience**

I. Introduction

There is an overwhelming volume of online audio and video materials that can be used by language learners for listening practice. However to be of any meaningful use their suitability must first be assessed, as motivated by concepts arising from research in learning and development. For example, Krashen's comprehension hypothesis [1] states that exposure to comprehensible input is key to language acquisition, citing evidence from studies reporting gains in different target language proficiency skills. This concept in language learning has been the basis for the development of learning platforms [2] and underpins the design of extensive learning activities [3], [4].

The evaluation of the comprehensibility of spoken materials, or *listenability*, can be carried out by teachers or self-directed learners, but the process can be complex and time-consuming. Learners are sometimes ill-prepared to choose materials themselves, as they find it difficult to identify materials that are appropriate for their levels, or are hampered by having limited digital literacy or preparedness to study independently [4], [5].

Automating the assessment of listenability would be of great assistance to teachers and learners. Developers of such systems would benefit from an understanding of the processes involved in evaluating the listenability of spoken materials. To this end, we create The Listenability Framework that identifies key influencing factors for listenability and the roles that they play in the assessment. We envision our framework to provide a grounding for design decisions regarding which characteristics of the spoken material, the listener, and the environment should be considered, all of which are factors that influence listenability according to surveys of listening comprehension research [6], [7]. It will also help identify what components in the listenability assessment process to model, and examine existing systems for further development.

To model listenability factors and their interactions for our framework, we propose using the Quality of Experience (QoE) principles. QoE refers to "the degree of delight or annoyance of the user of an application or service" [8]. A key feature of the QoE Framework is the identification of influence factors (IFs), which refer to "any characteristic of a user, system, service, application, or context whose actual state or setting may have influence on the QoE for the user" [8]. This user-centric and holistic approach lends itself well to representing the complex interactions of the different listenability factors. The QoE Framework has been shown to be applicable to various domains beyond traditional multimedia services and systems. Other frameworks based on the QoE Framework include those that can describe the Post-Stroke Quality of Life [9] in the context of healthcare and Audio QoE [10] for audio archiving. To our knowledge, no prior work has provided an understanding of listenability through the lens of QoE.

II. The QoE-Based Listenability Framework

Essential to the Listenability Framework is the depiction of the Listenability Assessment Process. This should highlight key internal subprocesses involved in the listener's evaluation of the comprehensibility of the spoken material, as well as the role of the identified major listenability factors in the assessment. In developing this, we first formally define listenability and identify the major influencing factors based on studies on listening comprehension. We then describe the listenability assessment process based on the *Quality Formation Process* presented in previous QoE studies.

A. Defining Listenability

Among the first published research to mention the term "listenability" is a study on predicting listener understanding and interest in radio newscasts [11]. Here, the term alludes to the "difficulty of spoken materials", a definition paralleling the use of "readability" formulae to measure the "difficulty of written materials". Listenability was more formally defined in

[12], by distinguishing it from related concepts of audibility and recognizability. In this paper, listenability is the "capability of being comprehended", which depends in part on audibility and recognizability. Audibility is concerned with the detection of sound, while recognizability refers to the ability to repeat or record a linguistic unit regardless of whether its meaning, if any, is conveyed. When the comprehension of meaning in the sound stimuli is concerned, we refer to listenability.

We identify four major listenability factors from reviews of listening comprehension research [6], [7]: Content, Delivery, Listener and Context. Content-based factors include characteristics of the material that reflect on the style of the language used [12], as well as the topic and information conveyed. Delivery-based factors, on the other hand, refer to the way the material is presented and the quality of the medium for presentation. It includes the spoken characteristics of the material, acoustic environment and any supplemental cues that may aid in the comprehension of the material. Listener-based factors pertain to characteristics of the target listener such as language proficiency and content preferences. Finally, context-based factors refer to the interaction environment in which the listening is taking place, e.g., is the learner working individually, is with peers or in a class, and are there learning goals and tasks such as comprehension questions that come with the material, and if so what type of questions are they.

B. The Listenability Assessment Process

We illustrate the Listenability Assessment Process in Fig. 1. The model is heavily derived from previous illustrations of the *Quality Formation Process* [8], [9], [13], [14], keeping its major elements. The listener, or learner in a language learning context, is represented by the large bounding box in Fig. 1. The process is shown here as the listener's comparison of the spoken material's *Sensed Nature* against its *Desired Nature*.

The *Quality Perception Path* represents the current experience of the listener with the spoken material or *Input*. This interaction allows for the formation of a *Sensed Nature* of the material by the listener, which can be influenced by the material's content and delivery, the context in which it is used, and the listener's characteristics. This is followed by the listener's *Reflection* on the *Sensed Nature* of the material, yielding a set of *Perceived Quality Features*. These features reflect not only the listener's understanding of the material but also the effort entailed to reach that understanding.

The listener's current experience is also influenced by expectations formed about the spoken material, which we refer to as *Anticipation* in Fig. 1. These expectations by the listener may already be present prior to engaging with the material. In a listening activity for language learning, for example, such expectations may be based on a pre-listening activity that involves previewing the vocabulary used or discussing the topic of the spoken material [15]. Expectations may also change based on additional information derived during the interaction, i.e., based on what is currently being heard. Influences on *Anticipation* is manifested by its connection with the *Reference Path* and influencing listenability factors. The

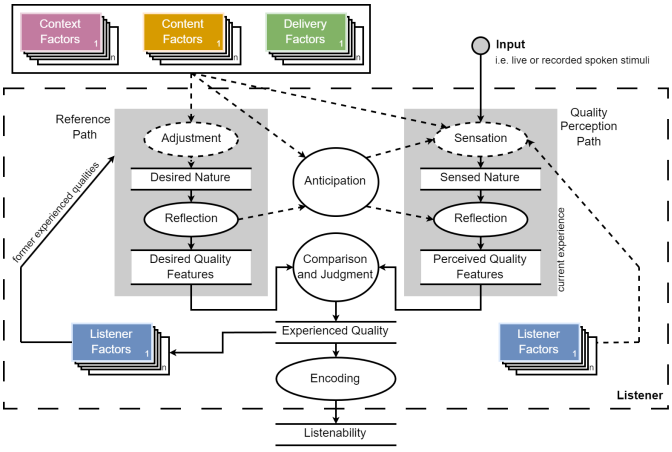

Fig. 1. The Listenability Assessment Process

Reference Path is similar to the *Quality Perception Path* but is involved in the formation of a *Desired Nature* of the material. It also "inherits a memory of former experienced qualities", as indicated by the feedback from *Experienced Quality* [8].

The listener's *Experienced Quality* of the spoken material results from the comparison and judgment of *Quality Features* that represent the *Desired* and *Sensed Nature* of the material. This leads to a general perception of whether the listener finds the material easy or difficult to understand. The *Experienced Quality* can be obtained from the listener, either as a descriptive level or score, via some *Encoding* process such as a survey [16], [17] or a comprehension assessment task [18].

III. Predicting Listenability

We unpack the major listenability factor categories into less abstract components to facilitate the creation of a feature set for developing a listenability assessment system. We base our findings on surveys of listening comprehension research and existing listenability assessment studies. We also illustrate how the framework can be used in the design of assessment systems and in the evaluation of existing implementations.

A. Expanding on Factors Affecting Listenability

We expand on the four major listenability factor categories in Fig. 2 to better identify features for listenability assessment. We identify five factors under the category of *Content*. Assessment via content involves looking at various levels of linguistic complexity, i.e., lexical, syntactic and discourse complexity. *Lexical complexity* looks at the relative frequency and variety of words and expressions while *syntactic complexity* refers to the phrasal and clausal structures used in the material. *Discourse complexity* on the other hand, considers the cohesion and organisation of the content. Other subcategories under *Content* include subject matter and explicitness. *Subject matter* refers to the topic and ideas covered by the material. We also consider *Explicitness*, as a material is easier to understand when ideas are presented more directly, requiring less effort to deduce the message conveyed [19].

Under *Delivery*, we have five factors. These comprise of *spoken language characteristics* specific to the target lan-

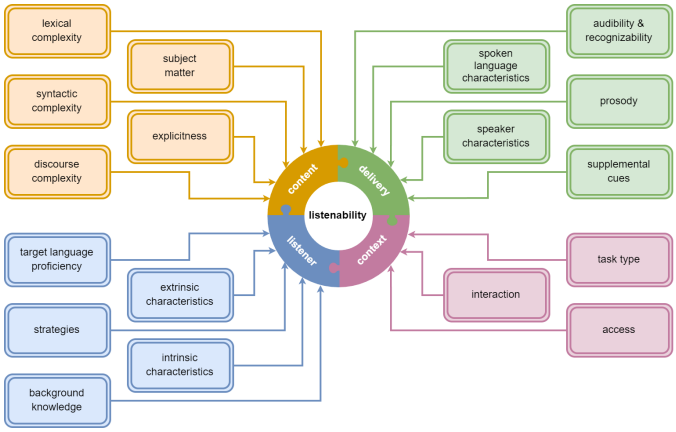

Fig. 2. Factors affecting the listenability of a spoken material

guage, such as phonological modifications or sandhi [16] and breached boundaries [20], which can impede listening in the target language. *Audibility* and *recognizability*, which are defined earlier, are also included. *Prosody* as a delivery-based factor includes stress and intonation patterns, as well as rhythm. We also consider *speaker characteristics* such as gender and accent, and the presence of *supplemental cues*, such as interactive transcripts, and visual information obtained when watching videos which may aid comprehension during a listening or viewing activity [6].

We also identify five *Listener*-based factors. Characteristics that are inherent to the listener such as age and memory [6] are collectively referred to as *intrinsic listener characteristics*. In contrast, factors arising from the listener's interaction with the spoken content, such as attention, affect, and interests, are referred to as *extrinsic listener characteristics*. Also included are the listener's *target language proficiency*, i.e. the listener's ability to accurately communicate in the target language, and their *background knowledge* or familiarity with the subject matter covered by the spoken material. Finally, we have *listener strategies*, referring to the listener's ability to effectively use learning tools to better comprehend the spoken material.

Finally, we consider three *Context*-based factors. *Task type* refers to expectations of the spoken material creator on what information must be comprehended by the target listener. In language learning, the task type include pedagogic activities from which the listener, in this case the learner, can assess his or her understanding of the material. We look at *interaction* to refer to whether the listening activity is carried out independently or with others, as it may allow or deny listeners opportunities to understand the contents of the spoken material better [21]. We also consider here the effect of a mentor's presence, or whether it is a computer-assisted activity or not. Meanwhile, *access* refers to whether listeners engage with the material in real-time (as in a lecture or speech) or in a digital format, allowing the possibility of multiple access.

B. Assessing Existing Implementations

In developing assessment systems based on our framework, e.g., for recommending listening materials language learners, it is desirable to use features representing the four major listenability factors. Based on the Listenability Assessment Process in Fig. 1, these factors affect the formation of the desired and sensed nature of the spoken material. In addition, our QoE-based framework endorses modeling the listener's collective former experienced qualities, recognizing how this influences the desired nature of the spoken material. This envisions a personalised process of spoken material analysis with the target listener in mind.

We recognize however that implementations may have technological constraints or focus on the use of a subset of factors for listenability assessment, holding other factors constant. An example would be the implementation of a *script listenability* assessment system, where we only use features related to the style of the language use [12], i.e., *Content*-based factors. Such is the focus of earlier work, either by investigating the use of a readability formula to predict listenability [11], [18] or creating a separate listenability formula [22]. We note however that one must be aware of the limitations of such implementations. Our preliminary work on the utility of various readability formulae to predict listenability show that they alone are insufficient to predict subjective listenability evaluations [23].

More recent implementations have incorporated both *Content*- and *Delivery*-based features [16], [17], [20], leveraging advances in speech and language processing. However, many have yet to consider how to include *Listener*- and *Context*-based features, and any use of listener information for assessment has been limited, such as the use of test scores [16] or information based from language learners [20]. We can advance research on this area by considering related fields. For example, we can look at recommender systems to develop and use digital learner profiles for course or material recommendation [24], which can serve to model collective former experienced qualities by the listener.

IV. Summary and Conclusion

In this paper, we present a new Listenability Framework to illustrate the process of assessing spoken material comprehensibility. By leveraging Quality of Experience principles, we establish a holistic approach to describing the complex interactions among the different factors that influence listenabilty that is also grounded on listening comprehension research and studies on listenability assessment. Our proposed framework serves as a valuable guide to the development of automated listenability assessment systems, as well as a means of examining existing systems for further development. In the context of language learning, such systems can help provide personalized learning experiences, through which materials can be recommended that suits the learner's target language proficiency, interests, and learning goals.

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References

[1] S. Krashen, "4. The Comprehension Hypothesis Extended," in *Input Matters in SLA*, T. Piske and M. Young-Scholten, Eds. Bristol, Blue Ridge Summit: Multilingual Matters, 2008, pp. 81–94, ISBN: 9781847691118. DOI: 10.21832/9781847691118-007.

[2] P. Lin, "Developing an intelligent tool for computer-assisted formulaic language learning from YouTube videos," *ReCALL*, vol. 34, no. 2, pp. 185–200, 2022. DOI: 10.1017/S0958344021000252.

[3] D. Malakowsky, "A Modified Extensive Reading and Repeated Reading Intervention with Adult ESL Students," *Reading in a Foreign Language*, vol. 35, no. 1, pp. 72–99, 2023, ISSN: 1539-0578. [Online]. Available: https://hdl.handle.net/10125/67439.

[4] B. Milliner and R. Chaikul, "Extensive Listening in the ELF Classroom with ELLLO," *The Center for ELF Journal*, vol. 4, pp. 36–50, 2018.

[5] A. Takaesu, "TED Talks as an Extensive Listening Resource for EAP Students," *Language Education in Asia*, vol. 4, no. 2, pp. 150–162, 2013. DOI: 10.5746/LEiA/13/V4/I2/A05/Takaesu.

[6] J. Rubin, "A Review of Second Language Listening Comprehension Research," *The Modern Language Journal*, vol. 78, no. 2, pp. 199–221, 1994, ISSN: 0026-7902. DOI: 10.2307/329010.

[7] A. Bloomfield, S. C. Wayland, E. Rhoades, A. Blodgett, J. Linck, and S. Ross, "What makes listening difficult? Factors affecting second language listening comprehension," University of Maryland, 2010. [Online]. Available: https://apps.dtic.mil/sti/citations/ADA550176.

[8] European Network on Quality of Experience in Multimedia Systems and Services (COST Action IC 1003), "Qualinet White Paper on Definitions of Quality of Experience," P. Le Callet, S. Möller, and A. Perkis, Eds., Mar. 2013. [Online]. Available: http://www.qualinet.eu/resources/qualinet-white-paper/.

[9] A. Hines and J. D. Kelleher, "A Framework for Post-Stroke Quality of Life Prediction using Structured Prediction," in *2017 Ninth International Conference on Quality of Multimedia Experience (QoMEX)*, 2017, pp. 1–6. DOI: 10.1109/QoMEX.2017.7965672.

[10] A. Ragano, E. Benetos, and A. Hines, "Adapting the Quality of Experience Framework for Audio Archive Evaluation," in *2019 Eleventh International Conference on Quality of Multimedia Experience (QoMEX)*, 2019, pp. 1–3. DOI: 10.1109/QoMEX.2019.8743302.

[11] J. S. Chall and H. E. Dial, "Predicting Listener Understanding and Interest in Newscasts," *Educational Research Bulletin*, vol. 27, no. 6, pp. 141–168, 1948, ISSN: 15554023. [Online]. Available: http://www.jstor.org/stable/1473082.

[12] K. Harwood and F. Cartier, "On definition of listenability," *The Southern Speech Journal*, vol. 18, no. 1, pp. 20–23, 1952. DOI: 10.1080/10417945209371245.

[13] A. Raake, *Speech Quality of VoIP: Assessment and Prediction*. Hoboken, NJ, USA: John Wiley & Sons, Inc., 2006, ISBN: 0470030607. DOI: 10.5555/1204067.

[14] S. Schmidt, *Assessing the Quality of Experience of Cloud Gaming Services*. Springer Nature, 2022. DOI: 10.1007/978-3-031-06011-3.

[15] J. Field, "The Changing Face of Listening," in *Methodology in Language Teaching: An Anthology of Current Practice* (Cambridge Professional Learning), J. C. Richards and W. A. Renandya, Eds., Cambridge Professional Learning. Cambridge University Press, 2002, pp. 242–247.

[16] K. Kotani and T. Yoshimi, "Effectiveness of Linguistic and Learner Features to Listenability Measurement Using a Decision Tree Classifier," in *Proceedings of the 3rd Workshop on Natural Language Processing Techniques for Educational Applications (NLPTEA2016)*, Osaka, Japan: The COLING 2016 Organizing Committee, Dec. 2016, pp. 6–10. [Online]. Available: https://aclanthology.org/W16-4902.

[17] S.-Y. Yoon, Y. Cho, and D. Napolitano, "Spoken Text Difficulty Estimation Using Linguistic Features," in *Proceedings of the 11th Workshop on Innovative Use of NLP for Building Educational Applications*, San Diego, California: Association for Computational Linguistics, Jun. 2016, pp. 267–276. DOI: 10.18653/v1/W16-0531.

[18] K. A. Harwood, "I. Listenability and readability," *Speech Monographs*, vol. 22, no. 1, pp. 49–53, 1955. DOI: 10.1080/03637755509375133.

[19] M. Rost, *Teaching and Researching: Listening*, 2nd ed. Routledge, 2011. DOI: 10.4324/9781315833705.

[20] M. S. Mirzaei, K. Meshgi, and T. Kawahara, "Exploiting automatic speech recognition errors to enhance partial and synchronized caption for facilitating second language listening," *Computer Speech & Language*, vol. 49, pp. 17–36, 2018, ISSN: 0885-2308. DOI: https://doi.org/10.1016/j.csl.2017.11.001.

[21] A. J. Lynch, "Grading foreign language listening comprehension materials : The use of naturally modified interaction," 1990. [Online]. Available: https://era.ed.ac.uk/handle/1842/19064.

[22] I. E. Fang, "The 'Easy listening formula'," *Journal of Broadcasting*, vol. 11, no. 1, pp. 63–68, 1966. DOI: 10.1080/08838156609363529.

[23] M. G. A. Bayona, A. Hines, E. Gilmartin, and E. Uí Dhonnchadha, "An Evaluation of the Use of Text-Based Comprehensibility Measures on Online Spoken Language Learning Materials," in *2023 34th Irish Signals and Systems Conference (ISSC)*, 2023, pp. 1–6. DOI: 10.1109/ISSC59246.2023.10162065.

[24] Q. Zhang, J. Lu, and G. Zhang, "Recommender Systems in E-learning," *Journal of Smart Environments and Green Computing*, vol. 1, no. 2, pp. 76–89, 2021. DOI: 10.20517/jsegc.2020.06.