

Precision Language Education: A Glimpse Into a Possible Future

Andrew-Peter Lian

andrew.lian@andrewlian.com

*Suranaree University of Technology,
Ho Chi Minh City Open University,
University of Canberra*

Pannathon Sangarun

pannathonsangarun@gmail.com

Suranaree University of Technology

ABSTRACT

This is a reflective article on “precision language education”. This concept is derived in part from “precision education” which, in turn, is derived from “precision medicine”. Precision language education heralds a new way of dealing with individual differences by effecting as precise a diagnosis as possible on each language learner, thus triggering specific interventions designed to target and respond to each person’s specific language-learning problems. The article develops the logic of precision language education, including the ways of eliciting and making visible, for both learner and observer, problems and difficulties to be diagnosed and remedied. It then briefly discusses the connection between personalized education and precision education before moving on to offer illustrative examples of precision language education at work which draw on a multiplicity of ways of addressing learning issues, including exploiting neuroplasticity. They include: an answer-evaluation and markup system, a phonetic correction system for three pairs of vowels and a neurological profiling system for guiding the forms of intervention applied. The article concludes with an argument that, in addition to offering a framework for action, precision language education enables the development of a flexible, coherent, “precision” mindset that is of benefit for generating individualized language learning systems to better meet the demands of the highly mobile, globalizing world of the 21st century.

Keywords: precision education; precision language education; individualized; diagnosis; intervention

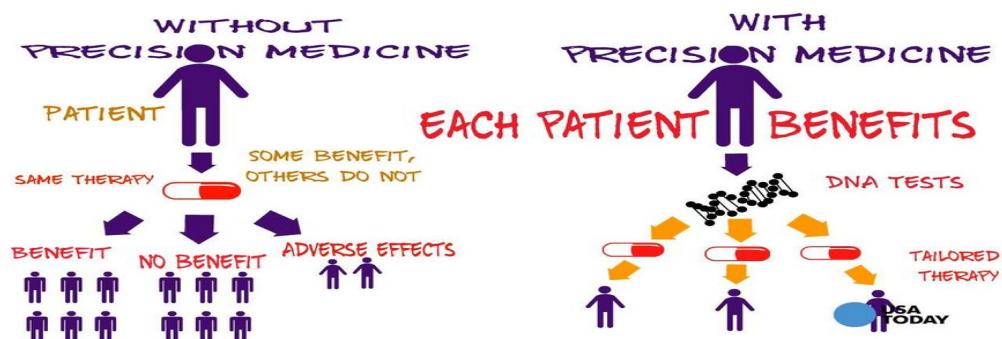
INTRODUCTION

The concept of “precision education” has only just begun to get traction in the field of education in general. So far, however, the concept of “precision *language* education” remains essentially unexplored. This reflective article will seek to undertake a preliminary discussion of the concept of precision education in the context of language education, with a special focus on learning and teaching¹.

The concept of precision education has been inspired by, but is not identical with, the concept of precision medicine that began to receive support during the Obama administration in the United States. “Precision medicine” saw the light as the result of dissatisfaction by some members of the medical profession with approaches to patient treatment. In particular, there is a growing understanding that a person’s disease is *their* personal disease rather than a

¹ It will develop and extend one of the authors’ reflections on the subject as presented in Vietnam in June 2016: Lian, A.-P. (2016). [Plenary session] Toward Precision Education: Second/Foreign Language Education in the Context of ASEAN in the 21st Century (Precision Language Education). Presented at the ICLD 2016 Conference, Ton Duc Thang University, Ho Chi Minh City, Vietnam.

normalized idealization of that disease. Although not stated explicitly, the move to precision medicine reflects an implicit critique of statistical approaches to medicine with their risk of sampling errors and sample definition, normalisation and exclusion of outliers that tend to encourage a one-size-fits-all approach to treatment that does not actually meet the specific needs of patients in the treatment of their personal diseases. The diagram below will help to illustrate.



(Lee, 2015)

The following explanation in layman's terms, quoted from a popular but respected website (WebMD) will explain the diagram a little:

Precision medicine revolves around the idea that a condition -- like cancer or heart disease -- in you isn't necessarily the same as in someone else. Instead, the genes you got from your parents, and the environment you live in, can influence your health, the symptoms you have, and even how well treatments might work.

If scientists can understand the root of these differences, they think they can develop treatments that are more effective.

and

It's becoming clearer that medicine is not one-size-fits-all. For example, a treatment that helps shrink one person's tumor or eases their arthritis symptoms doesn't always work for somebody else.

Picture this: You get detailed tests that can gauge how your arthritis or cancer differs from someone else's. Then you get a treatment that's tailored to you, rather than to anyone else.

Precision medicine, at its core, is about matching the right drugs to the right people.

But today it's not yet possible for every disease. So even though it sounds like a great idea, your doctor might still give you the standard drug that most other people get.

(WebMD, 2016)

The same principles are applicable to (language) education with the focus now shifting away from group characteristics (e.g. statistics or the often-recommended needs analyses) toward actual difficulties experienced by learners as they engage with the learning process. This, in turn, leads to the concept of "precision education" and "precision language education". While, nowadays, we often pay lip service to the notions of individual differences (e.g. we say that no two learners are alike) and individualization/ personalization (because of individual differences learners need individualized/ personalized assistance to maximize learning outcomes), in reality learner-centredness is often reduced to vague, relatively unstructured interventions such as group/ collaborative work where individualization is meant to emerge from the interaction between members of the group (students' peers) and others, if possible, such as teachers, friends and experts. This does not mean that group work or similar interventions is useless or without value (it has many advantages), but it does mean that, inevitably, we encounter conceptual vagueness that needs to be clarified.

Of course, the nature of (language) learning is different from the nature of medical intervention with many more undefined, and perhaps essentially undefinable, variables for any particular context. We may not be able to be “precise” in all possible aspects of how we learn even though research efforts to identify individual differences are not entirely new. However, despite these efforts, a precision mindset has not become common, at least not yet. Perhaps a change in mindsets (changing the way we look at things²) by focusing on the word “precision” as a reference point may enable us to do better. “Precision education” and “precision language education” might offer us the opportunity to step outside the fuzziness of some of our current practices (and/or sense of helplessness about them) and improve what we are doing. The essential characteristic of precision (language) education is the desire to access information that is as detailed and accurate as possible about learner characteristics and performances in order to initiate the most effective intervention in support of the students’ learning efforts. This implies, to the extent possible (not all situations may permit this), conducting increasingly accurate, often interdisciplinary, research to develop systems capable of responding to learners’ individual needs or optimising group experiences by tapping into shared learning mechanisms. Some of these systems will be technological in nature or depend on technological support. Systems such as these will become increasingly necessary as demand grows for both traditional (classroom-based) and non-traditional (e.g. self-study) language-learning opportunities in a world of hugely increasing globalization where English has already become the lingua franca. This will be of special relevance in regions such as ASEAN where the number of learners in need of high-level language skills, often at short notice, will rise sharply as a result of the new mobility opportunities provided by governments in the region.

While precision education is developing somewhat, precision language education is essentially invisible. This can be gauged in the following results from Google and Google scholar searches conducted on 28 October 2017³ by entering the phrases “precision education”, “precision medicine” and “precision language education” into both Google and Google scholar, and stipulating various years.

Year	Precision Medicine		Precision Education		Precision Language Education	
	Google	Google Scholar	Google	Google Scholar	Google	Google Scholar
2017	187,000	15,500	214	11	0	0
2016	141,000	15,600	98	11	0	0
2015	86,800	9,920	46	8	0	0
2014	44,100	6,100	48	7	0	0
2013	27,300	4,470	38	8	0	0

From these results, it is clear that the term “precision education” has only recently begun to have any currency at all while “precision language education” still has none. It also shows the relative growth of the concept of “precision” in education.

While the Google searches in table 1 show a low-level presence for “precision education” and no presence for “precision language education” on the Internet, in fact some initiatives in both areas are actually underway even though the detail of their activities remains somewhat unclear.

In what appears to be a radical move, National University in the United States, on the initiative of its President, Dr. David Andrews, has set precision education as a university priority for all sectors and has created the *National University Precision Institute* in support of what will clearly be a research-based initiative. The move flags that, henceforth, all faculty

² Cf. Max Planck’s insightful statement (if actually produced by Max Planck): “Change the way you look at things, and the things you look at change” (Planck, n.d.).

³ This has changed slightly since then.

members will need to develop a research-based mindset in relation to pedagogy. In the Institute's own words (on its webpage):

National University commits to create a fully integrated, comprehensive educational environment by utilizing advanced technologies, effective communication tools and interactive teaching methodologies that guide and orchestrate the allocation of resources according to the unique needs of individual students.

The Precision Education Initiative at National University is a university-wide initiative that is creating a new paradigm for student success by exploring ways to leverage technology, data, and communications to create a truly customized learning experience for all students. ("National University Precision Institute," 2017)

In a parallel development, the *Center for Language Acquisition and Precision Education (CLAPE)* was established by a consortium of leading universities (thus indicating the seriousness of the "precision education" enterprise). Notably, CLAPE is physically located in Xi'an, China. In its website's own words:

The Center for Language Acquisition & Precision Education (CLAPE) is an international cross-disciplinary institute established through the cooperation of Yale University, Harvard University, University of Toronto, Queen's University, Brock University, Ohio University, Xi'an Jiao Tong University, Shaanxi Normal University, Beijing International Studies University, Xi'an International Studies University and other research institutions. CLAPE is based in the city of Xi'an [...] The purpose of establishing CLAPE is to facilitate studies on language learning and teaching by launching cross-discipline projects through fostering and encouraging international cooperation. CLAPE will offer a platform for worldwide scholars to strengthen academic communications and cooperation, to transform academic findings and theories into practice, and to support cross-disciplinary linguistic studies and education reforms based on a solid foundation of evidence-based research.

("Center for Language Acquisition & Precision Education," 2017)

DEFINITION OF PRECISION

Given that precision education is still in its infancy, there is no fully agreed-upon understanding of the meaning of the word "precision". Elaborating slightly on previous comments, in the authors' view, precision education should, by virtue of the partial definition given above and the spirit of the "precision" project, imply providing accurate, detailed, timely, adaptive and contextualised personalised data so as to facilitate intervention either by the learners themselves, teacher/experts or by teacher/expert surrogates e.g. specially-constructed computer programs. It may not always be possible to provide all of these features for precision support at any one time, but these terms will serve as a reminder of what to aim for.

As a logical extension, precision education also implies the performance of appropriate research to enable the provision of the accurate, detailed, timely and contextualised personalized data required to accomplish the above. Thus, the "precision" project is essentially research-based, ongoing and open-ended, with new directions being identified in response to changes in contexts and learners. At the same time, research performed should, in principle, provide an increasingly accurate representation of how learning happens in the population that it is serving and how it may evolve over time according to circumstances.

Having said that, other forms of precision education have been proposed which are more reflective of teacher control. Paradoxically, an example of such an attitude comes from the Precision Education Blog at National University, the home of precision education in the United States. One of the professors writes: "I started with the course learning outcomes, which are established, well-defined, and standardized. I took each of those and broke them

down into four to six micro-competencies. I knew different students would learn those competencies differently, so I looked for a variety of learning objects, or modes of learning, for each micro-competency.” Of course, the intent here is to provide students with a variety of experiences from which to choose and which, by virtue of this choice, would fit into the precision education mould. What is lacking though, despite the clear goodwill displayed by the professor in question, is the learners and their contributions. All the choices appear to be made by the professor: he has broken the learning tasks into “four to six microcompetencies”, he “looked for a variety of learning objects”, he determined the “modes of learning” for each micro-competency. He did this on behalf of learners but without their participation in any sense. At best they are his guesses as to what would be suitable, or interesting, or valuable. In this kind of precision education model, much if not all of the power remains vested in the teacher with the students being given a choice of learning materials and approaches rather than having no choice. Of course, this is better than having no choice at all but lacks the level of autonomy and student-centredness deriving from the concept of precision education. This example demonstrates how, on the one hand and with all the good will in the world, it is difficult to give up teacher-control and, on the other hand, how complex precision education actually is. Arguably, though, this is only the beginning of an iterative process that will develop over time and will lead to the flexibility and student empowerment of true precision education.

PRECISION LANGUAGE EDUCATION IN ACTION

With the preceding remarks as a background, what might a learning system based on precision language education look like? Arguably, it would be comprised of at least two elements:

1. a space for eliciting language performances and, consequently, learner difficulties (if any) to be dealt with using precision-based assistance, and
2. a space⁴ for providing precision-based assistance.

ELICITING LANGUAGE PERFORMANCES AND LEARNER DIFFICULTIES

There are many possibilities for doing this. For instance, one could use a task-based learning environment (e.g. Sangarun, 2010; Willis, 1996), a macrosimulation environment (Lian, 2004, 2011; Lian & Mestre, 1985; Lian & Moore, 2014) or a Self-Organising Learning Environment (SOLE) (Mitra & Dangwal, 2010). All three approaches share the following characteristics: they are all focused on the performance of complex communicative tasks drawing simultaneously on a multiplicity of linguistic, cultural and other communicative skills. This means that learners need to mobilise simultaneously the kinds of language skills required of them in real-life settings.

These environments, perhaps embedded in a rhizomatic structure of great flexibility and responsiveness (Lian, 2004, 2011) enable students to attempt to perform language tasks and to notice/assess whether they have succeeded or failed in accomplishing them. Success would require no significant action while failure to perform would require some kind of intervention to assist with task-completion. Such intervention could take many forms ranging from consultation with peers, friends and/or experts (including teachers) (face-to-face or online) to the use of specialised computer programs or other forms of technological or human assistance.

⁴ Of course, these spaces do not have to be physical spaces, although they could be. They are essentially operational spaces in whatever form is necessary at the time.

Together, these support facilities will help constitute each learner's Personal Learning Environment (PLE): a unique combination of people and facilities assembled by the learner, with or without external support (human or technology-based) in an attempt to solve one or more of the learning problems at hand (Lian & Pineda, 2014).

In closing this section, it should be pointed out that while we have argued in favour of self-managed/self-adjusting/self-organizing environments for learning within a precision-based mode, it is actually quite possible to implement precision education in an environment where control is fully vested in a teacher or other person in charge of the learning experience. In that case, one assumes that the information collected by the teacher will be used to the benefit of learners to meet their requirements.

PROVIDING LEARNERS WITH PRECISION-BASED ASSISTANCE

The question of what constitutes precision support in language education remains open as we are still only just beginning to implement the concept in educational circles. However, research does provide some pointers. Below are three illustrative examples of what precision support in languages might look like. With time there will certainly be many more and they will certainly be more sophisticated than described here. Before doing so, however, it may be worthwhile to distinguish between personalized language education and precision language education

PERSONALIZED VERSUS PRECISION LANGUAGE EDUCATION

While some do not distinguish between personalized education and precision education, the distinction is usually made. In fact, precision education tends to be seen as a component of full personalization (Ziegelstein, 2017). Others may argue that in fact it is personalization which leads to the concept of precision education. From the perspective of the writers of this article, it is suggested that personalization be considered as the starting point for identifying learners' needs and that solutions to meet those needs emerge essentially from attempts to be more accurate, more precise, in both how needs are defined and how those needs are met. In that perspective, personalization is considered to be a subset of precision education, with precision education being the ultimate objective of the research effort. The fact that, given our current state of knowledge and development, it may be unlikely, impossible or even undesirable to attain a high level of precision does not detract from the validity of reaching out for it.

EXAMPLES OF PRECISION LANGUAGE SUPPORT

In this part of the articles we describe a number of different tools as illustrative examples of what might constitute components of a precision language education system. Both the tools and their descriptions are not formalized in any way as the concept of precision language education is itself new and under development. Nevertheless, there are some quasi-self-evident features of precision language education tools that will emerge.

EXAMPLE 1: COMPUTER-BASED ANSWER MARKUP AND EVALUATION SYSTEM

The first example to be mentioned is a computer-based answer-evaluation and markup system used for judging short answers in computer-based interactions⁵. In the specific case to be examined, the system is used as part of a listening comprehension system where students are

⁵ Developed by Andrew Lian, © Andrew Lian 2017.

required to transcribe short chunks of language. The task to be performed is quite simple. Students listen to the chunk and write down what they think they have heard. This is a way for them to externalize their auditory perceptions and get feedback on the correctness or otherwise of their “guesses” in a confront, contrast and contest (3Cs) approach to perception (Lian, 2004). The assumption is that the more accurate the feedback, the more able they are to modify their perceptual/comprehension systems.

Most evaluation systems are relatively primitive and give either generalized feedback or imprecise feedback, often leaving the students to wonder at the nature of their errors and where exactly the error occurred in the string that they typed. In addition, most systems do not deal with common typos, such as the addition of extra spaces in an answer or the insertion of unexpected punctuation (a correct answer is judged as incorrect if one or more additional spaces or unexpected punctuation marks are accidentally added).

The system described here, developed by Andrew Lian and based on previous work with older technology (Cryle & Lian, 1985), takes account of extra spaces, punctuation etc. before processing the student’s answer. It then provides at least three different kinds of feedback. Most importantly, though, as opposed to other systems, it uses the student’s own input to identify, on a replica of the student’s input string, segments that are correct and segments that are incorrect and need to be modified. In so doing, it signals exactly where the problem is and, where possible, also provides specific feedback to help students repair the identified problems. With that feedback in mind, students can listen again, re-think/re-construct what they have heard to change how they process the incoming signals and get closer to the original language actually used in the text.

The following is a trivial example offered for illustration. Real life examples are more complicated. In our example, the students hear, and should write, the words: “So how do we learn?” The student sees the following screen and clicks on the **Chunk** button to hear the chunk:

The screenshot shows a web-based interface for a language learning activity. At the top, it says "This is question 02". Below this, there is a dropdown menu labeled "Select a chunk" with "02" selected. To the right of the dropdown are two buttons: "Chunk" and "Context". Below these is a video player with a play button and the text "Watch chunks and context here". Below the video player is another video player with a play button and the text "Watch entire video here". To the right of the video players is a large text input field. Below the input field is a yellow "Verify" button. At the bottom left, there is a red button labeled "Show/Hide Recorder" and the text "Record your voice here - Compare with model". At the bottom right, there are navigation arrows and an "Exit" button.

The student writes the unlikely (but possible) answer (it actually happened): “So how you have learn?” as below:

This is question 02

Select a chunk
02

Chunk Context

Watch chunks and context here

Watch entire video here

Record your voice here - Compare with model

Show/Hide Recorder

Please listen carefully then write down what you think you heard in the box below.
When you have made your guess, click the *Verify* button and follow instructions.

so how you have learn

Verify

The student then clicks the *Verify* button and sees the following marked-up version of their response:

This is question 02

Select a chunk
02

Chunk Context

Watch chunks and context here

Watch entire video here

Record your voice here - Compare with model

Show/Hide Recorder

Please listen carefully then write down what you think you heard in the box below.
When you have made your guess, click the *Verify* button and follow instructions.

so how you have learn
so how you have learn

Verify I give up

The student clicks on the underlined words “how you” and gets feedback (below the *Verify* button):

This is question 02

Select a chunk
02

Chunk Context

Watch chunks and context here

Watch entire video here

Record your voice here - Compare with model

Show/Hide Recorder

Please listen carefully then write down what you think you heard in the box below.
When you have made your guess, click the *Verify* button and follow instructions.

so how you have learn
so how you have learn

Verify I give up

There is a word that you are not hearing at all AND there is a word that you are not hearing correctly. Remember this and listen again.

From this single interaction sequence, the student can deduce that:

- (a) The word “so” is correct as it has not been touched,
- (b) The underlined segment “how you” is wrong but has helpful feedback available (in the form of a clickable link – it looks like a link and it is a link),
- (c) The word “have” is crossed out and in red. This means that it does not exist in the correct answer (the word may exist in real life but is simply not in the correct answer for this transcription),
- (d) The word “learn” is correct and remains untouched.

The student’s conclusions are expected to be something like:

- (a) DO use the words “so” and “learn” (and listen for them when you listen again to the chunk).
- (b) Do NOT use the word “have” (if you thought you heard it, you were wrong – listen again more discerningly and with a different meaning mindset).
- (c) Take account of the feedback displayed on clicking “how you” when you listen again and try to make sense of the chunk.

(Naturally, these markup conventions are explained at the start of the course or lesson).

On listening again, the students listen to the input *differently* on the basis of the feedback provided and construct/perceive the input differently through a “confrontation” of their *modified* understandings of the chunk and the actual input signals. The next time they attempt to respond to the task they may construct/perceive the correct answer immediately or they may get new feedback on their latest “guess”. This will help them to change their understandings of the listening text as they progressively adjust their processing systems to the constraints of the language being learned^{6 7}.

Different students will make *different* “guesses” and will receive *different* and, to the extent made possible by the feedback methods adopted, *precise* feedback resulting from the needs revealed from the clash between the students’ self (i.e. their understanding/perceptual systems) and the task to be performed. Given the computer-based nature of the interaction, students’ answers can be collected over time. As more and more answers are stored, analyzed and fed back into each lesson, the system will be able to provide increasingly precise feedback for even the least likely of students’ “guesses”.

Tools such as this are particularly connected to the notion of precision language education. Here, the computer program provides precise information for each student’s personal attempts at transcription. It gives feedback using the student’s own production, not someone else’s text, and points to the exact position of the problem in the student’s production. As a result, the student gets precise information as to which parts of his/her answer are correct, which parts are incorrect and, in many cases, automatic feedback is provided on incorrect student input. There is no guesswork here either on the part of the computer system or, more importantly, on the part of the student. Feedback is visible and to the point. Systems such as this are highly autonomous and self-managing precisely because of the accurate information that they provide. This precise level of information on students’ own productions helps them to restructure their processing of language in an entirely personal way which optimizes their learning experience. This level of personalized information is rarely, if ever, available in a standard classroom setting. Furthermore, such support will never be available in very large classrooms (e.g. 150 people) or in the teacher-less/self-directed

⁶ This is a very rudimentary description of the process that will be developed in other publications,

⁷ Note that in its present form the system uses traditional programming techniques. Future versions will be constructed using artificial intelligence and advanced pattern matching based on proximity algorithms.

learning systems that will become necessary as a result of globalization in Asia and around the world – unless supported by technology.

EXAMPLE 2: IMPROVING PERCEPTION AND PRONUNCIATION OF PAIRS OF ENGLISH VOWELS

The second in this set of illustrative examples emerges from studies in perception based on the verbotonal theory of perception and phonetic correction (Asp, Kline, & Koike, 2011, 2012, Guberina, 1956, 1972; He, Sangarun, & Lian, 2015; Lian, 1980). It has been one of the tenets of verbotonalism that perception and production of speech sounds is based on the recognition and internalization of frequency bands that are characteristic of each phoneme in a language. This is especially the case with vowels which, because of their stable structure, are recognizable through sets of standard frequency bands known as optimal frequency bands. In traditional verbotonal theory, these frequency bands are identified as octave bands (an octave is an interval between two tones, or notes in music, where the frequency of the second tone/note is twice that of the first tone/note e.g. the frequency band 256Hz – 512Hz is an octave). In principle, when exposed to hearing a specific sound through its optimal octave bands, language learners are expected to improve their ability to discriminate between the vowels involved and also to improve their pronunciation of each sound. For instance, one could take an audio recording of the word “ship” and modify it by using a set of electronic filters (a little like using a graphic equalizer on a sound system) to “push” the sound /ɪ/ of “ship” through a 1-octave electronic filter (in this case 1600-3200Hz). This will modify the sound to make its basic characteristics more salient and suitable for reception by EFL learners.

While this kind of intervention has been part of the dogma and the practice of verbotonalism (e.g. Mildner & Bakran, 2001), there seems to be a theoretical weakness in the model in that it appears to treat the community of learners as a single entity that is entirely homogeneous, with the same perceptual mechanisms operating identically for each member of the learner community. More recent ways of thinking (e.g. Lian & Sussex, 2017), suggest, however, that while individuals in the same sociolinguistic group may have similar perceptual and processing mechanisms by virtue of belonging to the same group, these mechanisms are in fact not shared by all individuals in precisely the same ways – and some may be significantly divergent given their individual histories. Thus, a more refined approach to the problem of perception and production appears necessary. Investigating such an approach was the task undertaken by Wen Fengwei⁸ for his yet unpublished doctoral study under the supervision of the authors, and on the basis of a model originally proposed by Andrew Lian and further refined by Wen. Such refinement is the essence of the precision language education approach which effectively stipulates that general solutions may not be sufficient for optimal results and that more and more precise solutions need to be discovered or created to secure high levels of success.

In his study, Wen tested a number of alternative optimal frequency bands comparing 3 vowel contrasts, such as /ɪ/ (as in “ship”) and /i:/ (as in “sheep”). His subjects consisted of adult Chinese EFL non-English majors studying in a Chinese university. He discovered that, in fact, several optimal frequencies could be identified depending on individual participants’ processing of speech signals, thus re-defining or at least refining the long-standing concept of optimal frequency as a single octave band. In particular, he found that a discontinuous frequency band was more effective than a continuous frequency band for *all* participants. He also discovered that, for most participants, a narrow frequency band component (e.g. 1/3 of

⁸ The authors are grateful to Mr. Wen, Fengwei for permission to refer to his yet unpublished doctoral dissertation. He has been consulted on the content of this section and his approval sought for information released here.

an octave) was more effective for correcting both perception and production than a full octave. For instance, the most successful corrective optimal for /ɪ/ (as in “ship”) was determined to consist of two components. The first was a low-pass filter component with a cut-off frequency set at 320Hz⁹ and the second was a frequency band with a range of 2419Hz - 3048Hz (1/3 octave) (bandpass filter¹⁰): Traditionally, the optimal corrective band for /ɪ/ is thought to consist of a single band-pass filter set at 1600-3200Hz. One of Wen’s innovations was to use a low-frequency, prosodic, component which added an additional right-brain stimulus to the processing of the vowel sound as the analysis of prosodic cues is right-brain lateralized (Herrmann et al., 2003).

Wen then used his multiple optimal frequency findings to diagnose each participant’s optimal frequency for each of the vowels being studied (i.e. he identified the frequency that was most effective for that person in terms of perception and production of each sound studied) and offered each learner a set of recordings filtered on their preferential frequency band. The participants then spent time performing simple listen-repeat exercises with no teaching of any kind. A control group performed exactly the same exercises also with no teaching of any kind. The only difference between the two groups was that the control group was not exposed to filtered language. Variables were strictly controlled, particularly in connection with time-on-task, and performance ratings were double-blind. The experimental group outperformed the control group by a factor of 5 times on average for both perception and production (including increased intelligibility).

While these results are still statistical in nature, Wen’s findings of multiple optimals represent significant progress in understanding how we perceive and produce speech sounds and how we can improve the learning of foreign language pronunciation. This was achieved through a three-step approach: (a) research to determine precisely the object of study (speech sound optimals in this case), (b) precise personalized diagnosis and (c) an appropriate form of intervention. In the context of the present article it also offers good evidence for the validity of a precision approach that, in this case, exploited the brain’s specialized processing functions. Any step that moves us away from “mass treatment” to full individualization is a step in the right direction. With time, it may be possible to personalize even further the process of identification of optimals for each learner.

GENERAL LEARNER CHARACTERISTICS: PERHAPS IN THE FUTURE

The next illustrative example describes a kind of intervention that is still very general in scope but that may move us toward more precise intervention in due course. It is inspired from a recent study published in *Neuropsychologia* entitled “Right: Left.: East: West; evidence that individuals from East Asian and South Asian cultures emphasize right hemisphere functions in comparison to Euro-American cultures” (Rozin, Moscovitch, & Imada, 2016). In this article, left and right brain activity of East Asian and South Asian cultures is compared to the brain activity of members of Euro-American cultures. While a great deal more research is needed to replicate and verify the outcomes of the research, the findings are suggestive of a connection between culture and hemispheric specialization: “These results support an “East - Right Hemisphere, West - Left Hemisphere” hypothesis, as originally proposed by Ornstein (1972)” (Rozin et al., 2016, p. 1 - abstract). While the authors do not subscribe to a view that would “ghetto-ize” different social and/or cultural groups of learners, it would be of considerable value in a learning/teaching context to know

⁹ A low-pass filter allows frequencies below a certain cutoff frequency (320Hz in this case) to remain in the speech signal. All frequencies above the cutoff frequency are removed.

¹⁰ A band-pass filter allows frequencies between two cutoff frequencies (2419Hz – 3048Hz in this case) to remain in the speech signal. All other frequencies are removed.

whether individual (language-)learners display a preference for different forms of brain processing. Such processing preferences could be established, for instance, through some of the tests used in the article to determine right or left-brain dominance for individuals and to maximize use of that knowledge to the benefit of learners. The danger, of course, is stereotyping learners negatively. However, as teachers, we categorize learners all the time. In a sense, that is our job and we pass judgments on learners constantly, except that we do not say so explicitly. Instead, we “grade” and “assess” them and “assist them according to their needs”. At the same time, we already have well-known studies that document significant differences between “East” and “West” such as Kaplan’s typological studies of writing patterns of ESL students (Kaplan, 1966). There is also Gardner’s theory of Multiple Intelligences (Gardner, 2011) which we use to categorize learners as well as a long list of learning styles proponents even though the concept of learning styles has recently come under attack. Categorization of learners is therefore not a new phenomenon although one must be careful not to over-generalize or create false mythologies. With good scientific evidence at hand, educators could cater to both general and individual learner characteristics, preferences or processing habits in a positive, culturally-sensitive and respectful manner that would facilitate learning significantly rather than applying a one-size-fits-all approach that would benefit some but disadvantage others (the antithesis of precision education).

SUMMARY OF THE ABOVE EXAMPLES

The three examples given above reflect the spirit of precision language education. They all share the following characteristics:

- A diagnostic phase
- An intervention tailored to respond as accurately as possible to the diagnosis (given the state of knowledge of the times and the physical facilities available)

Extending these two points, one might envisage a hierarchy of diagnoses and interventions organized along the general → specific axis or, if one prefers, along the global → detail axis.

It also becomes clear that, exercised effectively, the practice of precision language education brings with it the necessity for extensive data gathering to be used for refining concepts, improving diagnoses, providing better feedback and advancing knowledge in general. For instance, in the first example, it would be valuable to collect learners’ responses, button clicks, time taken to respond and interactions with other humans so as to develop a better understanding of how people learn, what they find easy and what they find difficult both as individuals and as a group. This information would be gathered locally and, ideally, would be distributed globally for others to use or benefit from (e.g. they could be collected inside a school but shared with others through a distributed resource and information network based, perhaps, on the SCORM standard or the emerging xAPI standard¹¹, also known as Tin Can). In the second example, it may mean observing closely the success or otherwise of the optimals identified and the learning system used and either modifying them personally or reporting them to a specialist research team. Results could be forwarded to the above-mentioned distribution network. Importantly, these changes in practices would create an indispensable requirement for research by all, including classroom teachers whose roles would change over time in unpredictable ways.

¹¹ SCORM and xAPI are e-learning software specifications that enable information about student performances to be stored and shared with others. They are normally managed through Learning Management Systems (LMS) such as the popular open-source Moodle which arrange for the information to be stored or shared.

Ultimately, thinking along the above lines signals a move toward action that emphasizes identification of personal characteristics, accurate analysis of personal needs thus generating optimal learning conditions and empowering learners to act more autonomously than in the past, with less monitoring by teachers and greater access to quality learning experiences possibly situated in Self-Organizing Learning Environments. This would lead to a re-definition of learning/teaching, the role of teachers and the nature of pedagogy.

But, what is it that gives value to the concept of precision language education? Arguably, we already have some good tools and good teachers might already be doing some of the things derived from the principles of precision education. It is true that there are good ideas everywhere but often they are independent of one another. The notion of precision language education provides a unifying structure, a mindset, that identifies a clear but flexible research and teaching/learning direction, thus eliminating haphazard research and creating unity of purpose and effort for researchers and teachers. Such unity does not mean creating a new orthodoxy with narrow boundaries but rather encourages research according to generally acceptable and accepted principles for development. It also provides an opportunity to encourage researchers to connect their work to that of others at no risk to the integrity of their projects and in a way that will develop a coherent language-learning infrastructure, both intellectually and physically, across the world to the benefit of all. It should be noted that research cannot and must not be restricted to the traditional fields of language and language education (e.g. linguistics, TESOL, SLA etc.) as these are too limited in scope. While not ignoring the traditional language literature, additional evidence drawn from neuroscience, critical theory, sociology and other areas would be of benefit.

Yet, that is not quite the end of the story. The precision education movement, by its very nature, signals quite starkly the recognition that, in the end, the learner is essentially alone in front of the task of learning, an inevitably solitary predicament (no matter how much help you get, no one can learn for you), embedded in a combination of special individual conditions that no one else faces in quite the same way. This realisation significantly changes, or should change, the way we, as researchers and teachers, look at the learning process and our responsibilities. Ultimately the concept of precision education should help to untangle this situation, at least partly, and may open up many research opportunities in support of the learning process. For instance, we may discover new dimensions to well-worn areas such as language anxiety and open up newer areas such as neurological profiling, neuroplasticity, even genetic studies of learners. Simultaneously, precision education also moves the focus away from the group, thus setting greater store on autonomy as a way forward for language learners.

CONCLUSION

The notion of precision education is not entirely new but is derived, most recently, from the medical field. The concept of precision medicine provides a convenient, recognisable and appealing platform, as well as a springboard, for the development of other precision "things", without the necessity for constantly restating and arguing for its basic principles. Essentially, collocating the word "precision" with "education" and "language education" etc. is an inspired choice and, in many ways, constitutes the real strength of the precision movement. The reason for this is that the word "precision", because it is so well understood by society at large, places intellectual and psychological pressure on the profession, both theoreticians and practitioners. And, if the word is not (yet) a "precise" description of what we can actually do in the field of "precision education", it certainly sets a direction that we can aspire to without too many misunderstandings. Given the number of variables that we have to deal with in the social sciences/humanities, we may never be able to be entirely "precise". However, the word

does set a sense of the kinds of challenges and states of mind that we should be aiming for. So, if we cannot actually attain precision of the kind available in the hard sciences (or even medicine which is on the margins), a sense of what to strive for may change the ways in which we do things and move the process forward intellectually and therefore practically.

This article has reviewed a new development in education in its application to foreign/second language learning and teaching: precision (language) education. This concept is very much at the beginning stages of its development but offers promising and exciting possibilities both in terms of research and practical outcomes. Yet, as with all apparently new things, one is led to wonder whether the procedures and practices described are not what good teachers and good researchers would do anyway. And perhaps, that is the case. But the use of the word "precision", a word that everyone thinks they understand, helps to effect a change in how we think about (language) learning. It creates a new focus, new psychological pressures and a new level of performance to be attained/achieved systematically rather than precariously or in piecemeal fashion. Ultimately, if enacted seriously, "precision" has the potential to set new standards for language professionals and to offer new help for language learners in a democratising, globalising world of exponential linguistic and cultural demands that requires greater individualization of the learning process to meet the growing demand.

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ABOUT THE AUTHOR

Andrew-Peter Lian is Professor of Foreign Language Studies at Suranaree University of Technology, Thailand, Professor of Postgraduate Studies in English Language Education at Ho Chi Minh City Open University, Vietnam, Professor Emeritus of Languages and Second Language Education at the University of Canberra, Australia.

Pannathon Sangarun is Associate Professor of English Language Studies at Suranaree University of Technology, Thailand.