For Each and Everyone

Catering for Individual Differences Through Learning Studies

Edited by
Lo Mun Ling, Pong Wing Yan and Pakey Chik Pui Man

Hong Kong University Press is honoured that Xu Bing, whose art explores the complex themes of language across cultures, has written the Press's name in his Square Word Calligraphy. This signals our commitment to cross-cultural thinking and the distinctive nature of our English-language books published in China.

"At first glance, Square Word Calligraphy appears to be nothing more unusual than Chinese characters, but in fact it is a new way of rendering English words in the format of a square so they resemble Chinese characters. Chinese viewers expect to be able to read Square word Calligraphy but cannot. Western viewers, however are surprised to find they can read it. Delight erupts when meaning is unexpectedly revealed."

— Britta Erickson, *The Art of Xu Bing*

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Predominant Explanations of Individual Differences and Methods of Handling These Differences

LO Mun Ling and PONG Wing Yan

Introduction

In 2000, the Curriculum Development Institute in Hong Kong initiated research with an aim to find ways to cater for individual differences in students attending mainstream schools in Hong Kong. Our research team, comprising twelve researchers and a consultant from Göteborg University, was one of five independent teams that worked on the project. The first task that we faced was to create a working definition of "individual differences," with the understanding that the term might mean very different things to different people and as a result would lead to varying ways of addressing the issue. The initial discussion focused on why people were so concerned about individual differences. We asked, "In a pluralistic society, don't we need people with various abilities, temperaments, and interests, who are able to contribute to, and take up, diverse roles in society? Indeed, is the world not a more interesting place when people are different from what it would be otherwise? " We tried to grapple with the concerns of educators and the government, to understand why "individual differences" is such a great issue.

In Hong Kong as in other places, students are put together in schools and in classrooms. They are often expected to learn at the same rate and achieve the same learning outcomes through engaging in the same activities. However, in practice it is observed that some students learn more effectively or faster than others, and this is often attributed to individual differences. As it is perceived that, within the same classroom, students learning at different rates and achieving at different levels is problematic, the fact that students differ is also regarded as problematic and as something that must be dealt with in one way or another.

Students' success and failure at school is often explained either by the individual differences between learners in their innate abilities or motivation, or by the appropriate or inappropriate application of teaching arrangements that the teachers use (e.g., see Entwistle, 1984). Each of these explanations is

associated with certain viewpoints on how the school or the teacher should handle the problem or remedy the situation. These are also the most predominant views held by teachers, teacher educators, and policy makers in Hong Kong.

In the space below, we explain why these views, though each has its own merits, are rather unproductive in helping children to achieve mastery of basic competences. Neither do they provide adequate help to teachers in dealing with the issue of individual differences within the constraints that they face.

However, the reader must be cautioned that, throughout our discussion, we refer to children within the range of "normal" abilities; that is, they are neither mentally impaired nor exceptionally gifted to the extent that they cannot benefit from an inclusive education.

Difference in learning outcomes and difference in ability

It is often observed that some pupils learn more quickly or more easily than others. An easy explanation of such a fact is that they are born with different innate abilities. The popularity of such a viewpoint is evident by the abundance of "check your own IQ" type publications available in local bookstores. It is believed that, because children are pre-wired with relatively stable but different abilities, the way to cater for individual differences is to identify and classify children into groups according to such abilities, and then teach them only those things they are capable of learning. This appears to employ the metaphor that children are different kinds of vessel with varying capacities. As you cannot pour one litre of water into a 500 ml vessel, you should try to fill it up only with 500 ml of water, or it will overflow. So, different strategies have evolved to match the input to the child's assumed capacity, including streaming, banding, the use of graded worksheets and differentiated curricula, and so forth. Whereas psychologists are divided on the question of whether there exists a general intellectual ability, whether such an ability (if it exists) may change significantly over time, or whether intelligence is in fact multiple rather than singular (Gardner, 1984), we would argue that, whatever the merits of the argument or usefulness of associated teaching arrangements suggested, there are two inherent problems associated with these viewpoints.

First, children classified as having lower abilities are deprived of the opportunity of learning that which they are perceived to be "unable to learn." This raises a question of social equity regarding whether children are being treated fairly. Moreover, the gap between the "more-able" and "less-able" students will be widened, thus aggravating the problem and increasing the need to cater for student diversity. Second, children who are labelled low ability are often able to surprise us by learning seemingly difficult things. For example, despite differences in rate of learning, most young children will

succeed in learning to speak their mother tongue with fluency by the age of five. For very specific abilities, such as memory and retention, many children of the same age may exhibit superior ability by demonstrating that they have excellent recall of their friends' birthdays, telephone numbers, and even pieces of song lyrics while, at the same time, showing great difficulties in recalling the facts stated in the textbook, which they committed to memory through repetition.

Measures such as streaming, banding, and curriculum setting, which reduce the possible diversity experienced in class, may help to bring about teacher confidence or encourage teachers to focus on teaching methods that are tailored to individual groups. However, apart from the two problems described above, educational research is replete with evidence that numerous deviant behaviours are, in fact, due to the effects of labelling which are not actually substantiated by rigorous ability measurements. Children in so-called "ability groups" often perform to teachers' expectations rather than to their real abilities. It has also been shown that students do pick up cues from the behaviours of teachers regarding their abilities, when they are treated differentially. This in turn affects how they account for their own successes and failures in schoolwork. Attribution of failure to lack of ability often leads to resignation and predictions of more failure (e.g., Werner, 1980). The danger of constructing a self-fulfilling prophecy about "ability" thus cannot be understated.

Difference in learning outcomes and difference in motivation

In educational research, the effects of pupil motivation on school attainment have been widely studied. Some researchers argue that the findings suggest that, for all ages and at all ability levels, pupils with higher motivation perform better than those with lower motivation (e.g., Solomon and Kendall, 1979).

Theories regarding motivation are numerous and varied. The traditional behaviourist model explains motivation according to reinforcements experienced through stimulus-response reactions but fails to account for the observation that most teachers have, that students subjected to similar "reinforcement" contingencies could exhibit vastly different levels of persistence or patience in dealing with the same task.

Cognitive theories of motivation tend to focus on the possible internal events that may give rise to the differences in engagement in tasks. Apart from the same question regarding whether motivation is a personal trait, or if it is, whether it is a stable one, the general view nowadays is that there could be different types of motivation or motivational style, and hence the distinction between extrinsic and intrinsic motivation. If extrinsic motivation is brought about by the teacher using strategies like games, praise, rewards, and

interesting activities, it may well help some students learn more efficiently, especially young children who often lack sustained concentration on one object.

One reason for a child's poor learning outcome may therefore be due to his or her not paying attention to what the teacher says, and so the child misses some important pieces of information. If children are motivated by what they are doing, they will pay more attention to it, be willing to spend more time on it, and so learn more effectively. This belief was widely held in the heyday of behaviourism, when learning was taken as a set of stimulus-response reactions. Though the behaviourist model is no longer thought to be adequate in explaining complex learning, it has been consistently applied to areas in which training is conducted through repetitive practice. For example, when a child is motivated to do sums, driven by an extrinsic reward, eventually, the child will master the skills of doing sums accurately and swiftly. However, one must be cautious in using extrinsic motivational measures such as teachers' sanctioning activities (e.g., praise and the show of displeasure, or rewards such as a degree qualification). They may induce desired student behaviour more effectively but do not guarantee deep understanding, or that "students will acquire the kinds of knowledge that will support new learning" (Bransford et al., 2002, 24). A typical example is the finding that even university students of physics did not really understand the physics that they learnt (Clement, 1982, 1983; Gardner, 1991, 152–5).

As far as intrinsic motivation is concerned, it is contextually and content bound. It is often observed that the same child who is described as being motivated in learning one thing may not show much or any interest in learning another thing within the same school curriculum or under the same teacher. Thus we cannot talk about motivation without referring to what is being learnt and how it is experienced by the learner — the object of learning (the concept of the "object of learning" is more fully explored in Chapter 2). Although some cognitive scientists have expressed the view that psychologists' accounts of motivation in learning can be nothing more than "warmed-over common sense" (Bereiter and Scardamalia, 1993, 101), we would at least agree that children are generally unable to acquire the sort of "intrinsic motivation" required to bring about a long-term engagement with the subject matter.

The argument about the high value of intrinsic motivation on learning, achievement, and creativity is often explained by increased effort and engagement due to the learner's experience of sustained pleasure or "flow" (Csikszentmihayi, 1988). The difficulty, however, is that schooling is structured in such a way that most children do not experience the teacher's teaching objectives as their immediate or felt needs. Young children are typically not interested in long hauls, as Skemp (1971) argued about the case of mathematics learning:

> [Mathematics] is widely known to be an essential tool for science, technology, and commerce; and for entry to many professions. These are goals which motivate many adults to mathematics; but they are too remote to be applicable to the early years of school, when we first begin mathematics. (1971, 132)

Even for learners with high intrinsic motivation, there is no guarantee that deep learning will result. Highly motivated scientists may have to struggle for years before they learn and see what is critical in their study, and come to a breakthrough in their research, as the well-known story of how Madam Curie discovered radon illustrates. Entwistle (1984), in summarizing many studies in psychology and educational psychology on intelligence, motivation, and study skills, came to the conclusion that such research had made relatively little impact on helping students to learn better. He blamed such researchers for taking only their own perspective and ignoring the students' perspective:

> These researchers continued … implicitly or explicitly to blame the students for low levels of academic attainment. Thus failure is explained away as the result of low ability or lack of organization or application. (p. 12)

To truly access the learners' perspective, we believe we have to

> … ask learners what their experiences are like, watch what they do, observe what they learn and what makes them learn, analyse what learning is for them. (Marton and Booth, 1997, 16)

Furthermore, in order for children to experience "flow," or the joy of learning, they must be able to experience the sense of curiosity and excitement about a subject. Thus, it is not possible to induce intrinsic motivation in students without first studying very carefully why the intended learning is relevant to the students, how it can be made easy to understand, accessible, and yet without loss of depth. Teachers have the responsibility of pointing the way and structuring student experiences to enable them to learn, instead of just leaving it to chance.

The above, of course, is not an effort to negate the importance of motivation but to point out that efforts to bring about intrinsic motivation may have only limited effectiveness without due consideration given to what is to be learnt and how it is experienced by the learner. We would also like to reiterate that extrinsic motivational measures such as teachers' sanctioning activities (e.g., praise and the show of displeasure) may produce some desired pupil behaviours but, as many experienced teachers would agree, it guarantees no deep understanding or learning unless the way the subject matter is dealt with and how it relates to the learners are seriously taken into account.

Difference in learning outcomes and difference in teaching arrangement

More recently, research on student learning has been moving away from seeing learning as mainly an individual construction of knowledge to emphasizing the social and cultural character of learning (Resnick, Levine and Teasley, 1991; Mercer, 2000). Learning, as these researchers argue, is seen as most effective when the learner is immersed in a community of practitioners such as in an apprenticeship arrangement (Lave, 1996), in which human artefacts, rather than just the brainpower of the learner alone, contribute to the learning outcome. Learning is therefore not just in the head but distributed in the environment. Although admitting that school knowledge is inevitably institutional and social in nature, they consider school learning the most alienated and ineffective form of learning, because the learning activity takes place in an unauthentic environment where the learning outputs are increasingly mental (rather than physical) in nature, and they are most unlikely to be anything immediately useful (Säljö, 1996). According to this view, school learning is almost destined to fail.

Accompanying such a shift in the conception of learning is the focus on the social interactions in the process of learning, as well as the stress on the need to create teaching arrangements that promote teacher-student interactions. There is an unprecedented emphasis on the importance of artefacts, context, set-up work, and grouping arrangements to facilitate the interaction between the learners as well as with the environment.

The presence of interactions, in our view, is a necessary but not sufficient condition for learning. Although we have observed instances of children learning better in authentic situations where there are social interactions and ample sharing of life experiences, it is hard to imagine that interactions alone will guarantee the achievement of the learning outcomes intended by the teacher in school. Emphasis on interactions can move us away from the directional nature of school teaching, and, as a result, the purpose of learning may become opaque, and the criteria used by the teacher in judging learning success may not be understood. The chance that the learner will learn what is expected of him or her is perhaps equally as great as that of the learner learning something he or she is not expected to learn.

More seriously, the fervour of "situated learning" and "social interactions" has created a kind of unfortunate misunderstanding among some practitioners. There is a belief that, once students form groups and participate in communal activities, learning will naturally take place. Concerning the issue of individual differences, there has been a view that the diversity among the members of a group will create, in an automatic manner, new learning experiences leading to knowledge construction.

What we wish to point out is that learning in school usually begins from

a situation in which the learners do not actually know what they do not know. This makes it impossible for the learner to play a part in setting the criteria for judging success. Educational research is replete with studies which show the huge gap between what Gardner and others refer to as "intuitive knowledge" that children bring with them to school and "school knowledge" that is intended for them (e.g., Gardner, 1991). The knowledge the teacher wishes to develop is often remote from the student's everyday experience. For example, children experience the sun rising in the east and setting in the west, but in school they are taught that this "phenomenon" is caused by the rotation of the earth itself. The rotation of the earth is not something that children can easily experience, but the rising and setting of the sun is "real" to their everyday encounter.

In ideal "situated learning," the learner is put among the "knowers," so that the learner learns intimately through modelling, interacting, and following the instructions of the "knowers." For example, in an immersion programme, a child who cannot speak English is put among native speakers of English, so the child learns through everyday interactions with these native speakers and acquires the language. However, it must be considered that, in school, this rarely occurs. In most cases, the teacher is the only "knower" in the classroom. By relying on small-group interactions, there is always the danger that children are deprived of the opportunity of being taught by a teacher. More seriously, they may be misled by one or other of their peers who take the role of "teacher" in the group.

It is thus dangerous to argue that the existence of individual differences within a group, rather than the deliberate guiding effort of the teacher, provides the impetus for learning. Although we approve of the rather positive disposition (as opposed to the generally negative view) towards individual differences, we hasten to add that the optimism that individual differences will automatically work for learning is completely unjustified and mislaid. Our view is that individual differences are a double-edged sword, which can facilitate learning when they are handled by a teacher who is able to harness them. When left to run its own course, individual differences can be a natural reinforcer for the "intuitive" knowledge we described above, adding difficulties to the pursuit of learning.

The rise of "situated learning" and "social interaction" theories has also added fuel to the debate regarding the effectiveness of various teaching arrangements, such as whole-class teaching versus individualized instruction, group discussion versus seatwork, small class versus large class, the use of technology in teaching versus the simple use of chalk and board, as if questions such as the guiding role of the teacher, the content of teaching (that is, what is to be taught) or the intention of the teacher and students involved and the actual learning outcomes (for example, whether students conduct the learning act to satisfy a drive for knowledge or if they are simply fulfilling their study requirements) are insignificant or of lesser importance.

To us, it is inconceivable that there is a best way of teaching anything, and it would be grossly inappropriate to make sweeping statements regarding the effectiveness of particular teaching arrangements (such as whole-class teaching versus individualized instruction, group discussions versus seatwork, small class versus large class, etc.) without making reference to what is intended to be learnt.

Summary

We accept that the school is a social institution that must have a prescribed curriculum and a set of expected learning outcomes for each grade level. This is to ensure that students will acquire basic competences in preparation for their future participation in a modern society. We also accept that, because of resource constraints, teaching in school must take place in groups and in a place called the "classroom." However, we believe that it is not necessary to view "individual differences" as problematic.

In this chapter, we reviewed a number of perspectives on individual differences. We have also explained why we believe the ways they propose for dealing with the issue would not be very useful for practicing teachers. In the next chapter, we present the view of our research team and how we propose to deal with the issue.

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Catering for Individual Differences: Building on Variation

LO Mun Ling and PONG Wing Yan

Introduction

Instead of seeing the learner as a set of stimulus-response reactions, a bundle of nerves, or a number on the score sheet of a test or an inventory, some educators believe that we should be looking at the issue from a more humanistic perspective that enables us to explain learning from the possible "experiences" that the student has gone through in the process of learning. This approach of studying learning, though still not favoured by most psychologists (probably due to the lack of experimental control), is increasingly favoured in the field of education. In this book, we present a view of learning that stems from a humanistic interest and, as a result, addresses learning from a pedagogical perspective.

In this chapter, we first explain our view of individual differences. We then illustrate how we understand learning, using a conceptual framework that is based on the Theory of Variation (Marton and Booth, 1997). We then put forth a theory of pedagogy which is premised on our view of teaching and learning; and finally, we explain how such a pedagogy can be used to cater for individual differences.

Difference in learning outcomes and difference in the way of seeing the same thing

In the past three decades, there has been an increasing interest in educational research on work related to students' understanding of science concepts and theories. What emerged is a conclusion that students do bring their own ideas and beliefs about the world (especially about natural phenomena) into the classroom. These ideas and beliefs, which are often in conflict with the science concepts that the teacher tries to teach, have been a major obstacle to learning. Based on a similar interest, a group of

researchers, led by Professor Ference Marton of Göteborg University, Sweden, developed a research perspective known as "phenomenography." Its main research programme was to explore and describe the differences in how people understood, experienced, or thought about a particular phenomenon or an aspect of the world. Based on a large number of studies, they arrived at an important conclusion; that is, people often experience the same phenomenon in qualitatively different ways. However, when these differences are rigorously examined, they are always limited in number (Marton, 1977). A frequently quoted example is Säljö's (1982) study on how people come to understand or experience a text. In the study, the researcher asked a group of university students to read a passage on the topic of learning, and then he probed how they understood what they had read. What he found was that, although these students were reading the same text, they actually derived different meanings from it. Eventually, two distinct ways of understanding the text were identified. Firstly, some students saw the text as having a sequential structure with different perspectives of learning being described but bearing no relationship to each other. The second view, as demonstrated by another group of students, was that the text contained a main theme (the forms of learning), illustrated by a number of sub-themes (different perspectives of learning). This group of students saw the text as having a hierarchical structure with clear relationships between the sub-themes and the main theme. Säljö also found that the students who understood the text in the hierarchical way were better able to grasp the main idea of the text than those who understood the text in the sequential way, in the sense that the former group of students demonstrated a more organized and meaningful way of understanding.

Seen from this light, it is not difficult to understand why learning outcomes often vary within a group of students. In fact, variations in learning outcome should be the norm rather than the exception, because, for the same learning material or teaching act, students might understand the material or experience the teaching act in different ways. For example, while some students may not see any relationship among the different parts of the teacher's presentation, others may understand the same presentation as containing a theme with subsuming or related parts. For the same act of teaching, some students may see it as the transmission of factual knowledge that can be retained by regurgitation, but others may see it as challenging their existing understanding and requiring deep reflection in order to fully comprehend what has been espoused.

Studies from the phenomenographic tradition have repeatedly provided a similar conclusion: although people do have qualitatively different understandings of a certain object, event, or phenomenon, one often assumes that others understand the object, event, or phenomenon in exactly the same way as one does. In teaching, it is only too easy for teachers to assume that

their students will understand their teaching only in the way that they intend. The first step to improving teaching is, therefore, for the teacher to recognize that the students may understand what he or she intends to teach in different ways, thus achieving different learning outcomes. It follows that the central task of teaching would be, first, to find out what these different ways of understanding are and, second, to consider how teaching should be structured to enable students to see what is taught in the intended way.

Pong and Morris (2002), in summarizing the findings of a number of meta-analyses on the effects of curriculum reforms on student achievements, also point out that some innovations, including those focusing on teaching styles or strategies, are of peripheral significance in exerting influence on student learning, and the crux actually lies in how a specific content of learning is made available to students. In Marton and Tsui (2004), a set of studies are used to illustrate that the way the specific content of learning is dealt with has a significant effect on student learning. These studies show empirically what might seem self-evident: it is more likely that students learn when it is possible for them to learn than when it is not. That is, it matters how the teacher structures the lesson to enable the students to see in specific ways what is to be learnt. Seen from this light, we think that teaching arrangements can only be judged by how the learning of *something* is being made possible. In other words, attention must be paid to what is to be learnt.

We believe that what prevents students from fully understanding their lesson in school is not primarily their lack of ability or the failure of teachers to arrange the classroom in certain ways (e.g., pair work, group work) but mainly students' incomplete ways of understanding what is to be learnt in the lesson. This may be caused by a number of reasons:

a.   Students bring with them "intuitive" ways of understanding, which may become obstacles to new ways of understanding when the two seem to be in conflict.
b.   Students fail to focus on all the critical aspects of what is to be learnt.
c.   Students have not been exposed to suitable learning experiences in the lesson that would have enabled them to learn.

For example, when a group of young children was asked to draw what they meant by the Earth being round, some representations showed the Earth as a disc, others as a hemisphere (e.g., Nussbaum, 1985; Vosniadou and Brewer, 1987, 1990, 1992, 1993).

Common to all these representations is the conception that people must stay on top of the Earth and not be hanging upside down. Thus, what presents itself as an obstacle to learning, in this case, is the gravitational force that keeps people on the surface of the Earth without falling off into space, even when they are seen to be upside down. The concept of gravitational force is therefore critical to making a correct interpretation of "the Earth is round." In other
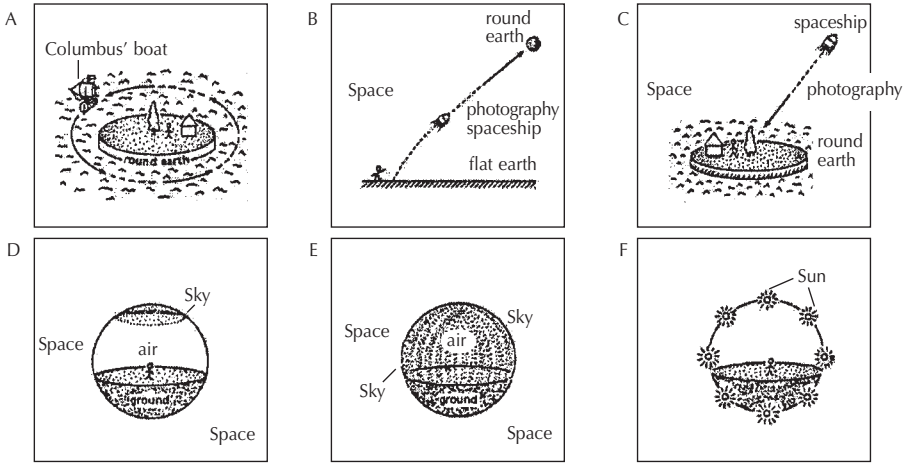
(Diagrams adapted from Nussbaum, 1985, 179, 182)

words, "gravitational force" is a "critical aspect" required to achieve the correct understanding (a detailed discussion of the idea of "critical aspect" is provided on p. 16).

One cannot make the learner discern a certain critical aspect (such as "gravitational force") by simply pointing it out. Learners must discern and make sense of what they discern for themselves. The following episode from our own research is revealing. A lesson was taught by a teacher to a Primary 3 class on the topic of the three states of water. The teacher first put some ice into a zipped plastic bag, and then she placed the bag of ice inside a metal can. Pointing to the water droplets forming on the surface of the can, the teacher asked the children where these water droplets came from. A discussion followed. In the end, the teacher helped the students to arrive at the conclusion that the water droplets came from air, as air contained water vapour that condensed on the cold surface of the metal can. After the lesson, a researcher interviewed a student about what she had learnt:

Student A: Ms W said that water will leak from the bag of ice when it is cold. It really did, the water made my hands wet …

Interviewer: Did the water leak from the bag of ice? But it was in a zipped plastic bag!

Student A: … It's like the bottle of drink I brought this morning; it was cold, and it leaked.

Interviewer: Let me ask you a question: is there water vapour in air?

Student A: No … Yes.

Interviewer: Why did you say "no" in the first place?

Student A: Because I remembered what Ms W said.

Interviewer: Don't try to recall from memory … . Think on your own. Is there water vapour in air?

Student A: No … I cannot see any …
Interviewer: Now, let me ask you again. Is there water vapour in air?
Student A: (Shaking her head firmly) No.
Interviewer: You said "no." Why?
Student A: Water vapour will vanish, and it will change back to air.

Although Student A, as a "good student," could repeat what the teacher told her in class, she had difficulty accepting the fact that the water droplets came from air. The notion that there is water vapour in air is simply not supported by her daily experience. This is another example of the difference in ways of seeing that needs to be dealt with. The way of seeing that arises from intuitive understanding stands in the way of the kind of understanding that schools intend to cultivate. Children do not learn by being told. Thus, effective teaching requires the elicitation of students' pre-existing understanding, and opportunities must be provided to students to build on their initial understanding. Students' preconceptions must be challenged and directly addressed, for them to be transformed or expanded (Bransford et al., 2002).

This is not to deny that children may be born with different abilities, and that some will therefore achieve far more or better than others. As teachers, there is nothing we can do about the differences in inherent aptitudes. We cannot make children naturally more able. But we believe that the range of abilities among children studying in mainstream schools should not hinder these children from learning what is intended in the school curriculum. Furthermore, a child has a right to reach her or his full potential. Therefore, in catering for individual differences, our focus is not on the variation in abilities; rather, we focus on the variation in learning outcomes. We believe that, if we can help students to acquire more powerful ways of seeing, it will be more likely that they are able to achieve the intended learning outcomes.

In any given lesson, there will be certain capabilities, e.g., understanding of a certain subject content and/or skill that the teacher intends to nurture. These are the intended learning outcomes, and they need to be clearly identified, because some are more important and worthwhile than others. There are also certain basic, core elements that everyone should learn and master, if one is to continue to learn and develop. These are sometimes defined as basic competences. Unfortunately, in schools, very little attention has been paid to these core elements. Moreover, for every worthwhile learning outcome that we can identify, there are some critical aspects that can be further identified and communicated. We believe that how the critical aspects are identified is not simply a matter of analysing and distilling them from the knowledge base of the subject disciplines. They have to be pinpointed from studying the interaction of the students with the subjects, and in the cultural context that the students are situated. These critical aspects may also vary according to the age, maturity, and experience of the students.

Our point of departure is that, by catering for individual differences, we mean that we are helping every child to learn what is worthwhile, essential, and reasonable to learn, so that every child can proceed in schooling. Next, we illustrate with examples our view of teaching and learning and discuss our approach to handling individual differences in the classroom.

Our view of teaching and learning

A number of concepts are pertinent in understanding our view of teaching and learning: object of learning, critical aspects, the structure of awareness, discernment, and variation. Since we believe that learning involves an interaction between the learner and what is to be learnt, we start by explaining the concept of the "object of learning."

The object of learning

The concept of the "object of learning" is derived from Brentano's principle of "intentionality" (1874). The concept of intentionality has nothing to do with intentions but rather with the observation that all mental acts are *directed* towards an object. Intentionality is concerned with the directedness of the mind. The key point is that one cannot simply experience without experiencing something. Similarly, one cannot think without thinking about something, nor can one learn without learning something. To talk about the learning act or behaviour alone would be hollow, if we do not at the same time make references to that which is learnt. Contrary to the belief of some educational theorists, therefore, we believe that one simply cannot develop thinking in isolation from the objects of thought. Learning is always the learning of something, and we cannot talk about learning without paying attention to what is being learnt.

We understand that, to most readers, the word "object" usually means "a visible or tangible thing." This is such a strong association that it is difficult to shift immediately to another dictionary meaning ("the end towards which effort is directed" or "an aim, goal or intention"). In our use of the term "object of learning," we take the latter meaning, i.e., the end towards which the learning activity is directed and how it is made sense of by the learner. Therefore, we take objects of learning as capabilities; they are not confined to the understanding of concepts or theories, but they can also be associated with skills, attitudes, or values. Thus, an object of learning has two aspects: a general aspect and a specific aspect. The general aspect has to do with the capabilities we wish to nurture in the students, and the specific aspect with

the subject matter we are dealing with and upon which the capabilities are being built or exercised.

In choosing an "object of learning," one cannot simply make reference to a set of topics or concepts and their places within the content or structure of an academic discipline, such as mathematics. Rather, the rationale for learning a certain concept must be found within the encounters between the learners and what is to be learnt, the value of which is derived from how such experiences open up opportunities for the learners to understand the world around them. For example, instead of taking the learning of "fractions" as a matter of course in the primary curriculum, we should ask stringent questions about the enabling functions that the learning of fractions brings for the learners in making sense of their environment. According to Marton and Booth (1997), when someone encounters a situation, some aspects appear to be more relevant to him or her than other aspects, and so the situation acquires a relevance structure: "the person's experience of what the situation calls for, what it demands" (p. 143). Since how one understands the situation depends on what critical aspects one attends to, the relevance structure of the situation largely determines the learning that takes place. Thus, if teachers are not being mindful of why students are learning what they are learning, it will be difficult for them to achieve deep learning outcomes.

Consequently, we should not simply cover the syllabus/curriculum prescribed without asking stringent questions like: Is the teaching of this topic worthwhile? How is it related to the goal of education? What capabilities do we wish to nurture in the students? What are the difficulties that my students will encounter when learning this topic? What must they have learnt before they can acquire this particular concept/skill? How is this topic related to the rest of the topics that are to be taught later in the year?

We further differentiate three types of object of learning: the "intended" object of learning, the "enacted" object of learning, and the "lived" object of learning (Marton, Runesson and Tsui, 2004). By having the two terms "enacted" and "lived" object of learning, we formally acknowledge the fact that students do not always learn what is intended. The enacted object of learning is the result of the teachers' enactment during the lesson, which makes it possible for the students to learn certain things; but it may equally well be possible, because of the dynamic situation of the classroom, that the intended object of learning and the enacted object of learning do not overlap. What a student actually learns depends on what he or she experienced, i.e., the lived object of learning. Each student may experience the same situation in different ways; thus the lived object of learning will be different for different individuals. That is, even when the teacher has made it possible for the students to learn certain things, we cannot assume that the students would experience them in the same way as intended and thus learn.

Critical aspects

Once we have defined the object of learning, we have to identify the critical aspects of the object of learning, in other words, what is critical in order for students to acquire the intended capability. As mentioned earlier, how we understand an object or a phenomenon depends on what critical aspects we focus on. In order for students to understand the subject matter under study in the way intended, teachers must be clear about what critical aspects needed to be discerned. This will firstly require them to have sound knowledge of the progress of inquiry, the terms of discourse, the relationship between information and the concepts that help organize that information in the discipline, in order to define the different aspects that should be learnt with respect to the object of learning. Secondly, among all the aspects, teachers should be able to identify those which are critical because they cause difficulty for the students in the process of learning. Some critical aspects are more easily discerned than others. Those aspects that are not easily discerned by the teacher often present themselves as obstacles to students' learning.

The reason why it may not be easy for teachers to identify the critical aspects that cause students difficulty is that teachers themselves often do not find these aspects difficult to discern, and may thus take them for granted. They are unable to highlight these aspects in their teaching because they are not even aware of them. As a result, a learning gap is left unattended. Those students who happen to be able to discern these aspects will come to a better understanding of the topic and are considered to be more able students by the teachers. Those who do not discern these aspects are left puzzled. These students cannot progress in their learning, not because they lack ability, but because they have missed some pieces of information that are very important. Consider the following question: What is the fraction represented by the shaded part?

Those students who take the unit as two squares will give the answer
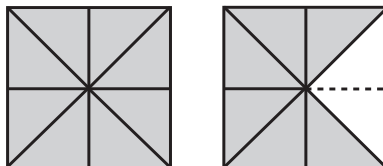
14/16, because they see the two squares as being divided into sixteen portions, each portion being 1/16 of the whole, and there are altogether fourteen such portions. In contrast, those students who take the unit as one square will give the answer 14/8, since they see each square as being divided into eight portions, each portion being 1/8 of a square, and there are fourteen of them. Both answers are, in fact, correct if the units are clearly specified. However, if

the teacher had in mind the question 8/8 + 6/8 and is using the diagram as an illustration, then the only acceptable answer would be 14/8, as one square has been taken for granted to be the unit. Students who see the unit as two squares and hence give the answer as 14/16 are very quickly given the feedback that their logic is wrong and that they are "less able" at learning mathematics. If the teacher wants to help students learn, he or she must first recognize the students' logic and how this logic may hinder their learning, and then address it accordingly. The recognition of what constitutes difficulties for the students in learning, however, requires the knowledge of what is critical for the learning. In this case, being able to focus on the "unit" is critical for the learning of fractions in mathematics to take place (Lamon, 1999). In other words, "unit" should be taken as a *critical aspect* for the understanding of fractions.

Another example is the study of astronomical phenomena in the primary general studies curriculum. The students are expected to learn topics like the four seasons, solar and lunar eclipses, tides, Earth, the Sun, the Moon, as well as the rotation and revolution of the Moon and Earth. Without carefully analysing what the object of learning should be, what the critical aspects are, and how these are related, teachers often feel that they are confronted with, and have to conform to, a curriculum which matches the description by Bransford et al. (2002) as failing to support learning with understanding because they "present too many disconnected facts in too short a time — the mile wide, inch deep problem" (p. 24). To help students learn these topics, the teacher must first be able to understand why this topic would be difficult for students to learn. The geocentric perspective is more akin to students' intuitive understanding, because they can only see the movements of the Moon and the Sun but not that of Earth, as they are standing on it. The teaching of these topics in fact requires students to change from taking a geocentric perspective to taking a heliocentric perspective. The object of learning here would be an understanding of the part of the solar system of which the Sun, the Earth, and the Moon are parts. Concepts like gravitational force and how it operates between these celestial bodies resulting in rotation and revolution are critical aspects to the understanding of the object of learning. Once students can fully grasp these concepts, they can easily explain and deduce for themselves natural events or phenomena like the different phases of the Moon, solar eclipse, lunar eclipse, as well as why there are four seasons on Earth.

The structure of awareness

Having identified the object of learning and its associated critical aspects, how are we going to help the students to learn them? As we have illustrated with the example of learning the three states of water (see pp. 12–3 above), students

do not learn by just *being told.* Rather, the way in which the learner comes to understand a particular phenomenon has to do with his or her *awareness* — the totality of a person's experience of the specified situation.

Human awareness has a structure. Since we cannot be simultaneously aware of everything at the same time, some objects or aspects will come to the fore of our awareness and be focused on, while those not focused on will recede into the background (Miller, 1956; Marton and Booth, 1997). For example, while you are reading this sentence, you are focusing on this sentence and its meaning. The sentence comes to the fore of your awareness. You are still aware of the rest of the text, but only as letters on the page. They have receded into the background. In your awareness, there are also other things. For example, you are still aware that you will be having dinner with your family in the evening, or that you need to get a certain assignment finished. However, they will remain in the background unless they are suddenly mentioned, as now. This is similar to a figure and ground relationship. When something comes to the forefront of your awareness, it is discerned from the background and is in your focal awareness. Learning is discerning something which has not been noticed or discerned by the learner, so that it becomes the figure instead of the background.

Every object has many aspects. For example, if you look at a hand, you may notice that there are five fingers, there are lines on the hand and prints on the fingers, etc. Depending on the features being discerned, we would have different understandings of the hand. The reverse is also true. Depending on how we aim to understand the hand, we need to focus on different aspects. If the purpose of looking at the hand is to read the fortune, then the pattern of lines on the palm is a critical aspect. If a criminologist is looking at the hand as a source of identification of a person, the fingerprint is a critical aspect. If an artist is looking at the same hand, the space that the fingers make when curved and the sense of power expressed by the shape become critical aspects. Thus, although a hand has many aspects, certain aspects are critical for a specific way of seeing.

If we wish to teach a child what a telephone is, we must help the child to focus on the critical aspects that make the object a telephone. Children who think that a mobile phone *is not* a telephone, or that a toy telephone *is* a telephone have partial or incomplete understanding of telephones, because they fail to focus on one of the critical aspects of a telephone — its functional aspect. That is, it is a tool for communication. Instead, they focus on the external features or parts that make up a telephone.

In order to help children learn, teachers must first identify the critical aspects and then help their students focus on these critical aspects at the same time, in order to bring about an intended way of understanding. Failing to discern a critical aspect may lead to obstacles in learning. Children's understanding of the fact that the Earth is round, mentioned earlier in this

chapter, is a good example. Children are quite ready to regurgitate the facts that their teachers have told them. However, when these facts do not fit in with their own logic, the children stick to their own ways of seeing things.

Discernment and variation

Learning by being able to focus on the critical aspects, as Bowden and Marton (1998) argue, is regarded as a function of *discernment* that presupposes an experienced *variation* in those aspects. People tend to notice things that stand out. Things tend to stand out when they change or vary against a stable background or when something stays unchanged against a changing background. For example, it is difficult for us to see birds in a forest when they are resting in trees, but when the birds fly, we notice them immediately. They are discerned from the same background when they move. As Bowden and Marton (1998) point out:

> When some aspect of a phenomenon or an event varies while another aspect or other aspects remain invariant, the varying aspect will be discerned. In order for this to happen, variation must be experienced by someone as variation. (p. 35)

In fact, even very young children can discern what is invariant in a spoken word amid the variation in tone, loudness, pitch, etc. — the meaning of the word.

The meaning we acquire of anything depends on our way of seeing it. People must be able to discern certain critical aspects of an object for them to see it in a particular way. Furthermore, we must discern all the critical aspects of a phenomenon *simultaneously* in order to gain a complete understanding of a phenomenon. Consider a detective looking at all the evidence collected from a crime scene. Some pieces of evidence are critical; others are just distracters. The detective may be looking at all the pieces of evidence that are critical for a long time without understanding what these tell him or her. When the moment comes that he or she can see these critical aspects *simultaneously*, so that their relationship to each other becomes clear, the detective will come to a new understanding of what happened, and solve the crime.

As another example, if I see or experience an object as a big, brown German shepherd dog, I should have discerned simultaneously some of its aspects, like size, colour, and breed. The meaning this object has for me is then a function of the discernment of those aspects. But how can I know that it is a big, brown German shepherd? How can I understand what a dog is if I have not encountered a dog, a cat, a cow, or other animals that I can compare it with? How can I know it is a German shepherd if I have never encountered

a Terrier, a Labrador, or some other breeds of dog? And how can I tell that it is a brown dog if I have not experienced a dog of another colour? To notice or discern an aspect, we not only need to pay attention to what it is but also to what it is not. In other words, we need to experience the variation in an aspect in order to be able to discern it in one but not in another way. For example, the concepts of "size," "breed," and "colour" in the example of seeing a big, brown German shepherd are experienced as dimensions of variation with respective values such as big and small, dogs of different breeds, brown and other colours. Each dimension of variation is a critical aspect (e.g., colour), and the values (e.g., brown) are critical features.

According to Marton and Booth (1997),

> … learning proceeds, as a rule, from an undifferentiated and poorly integrated understanding of the whole to an increased differentiation and integration of the whole and its parts … these wholes, the learner's initial ideas, turn out to be partial rather than wrong. They are the seeds from which valid knowledge can grow. (p. viii)
>
> The whole needs to be made more distinct, and the parts need to be found and then fitted into place, like a jigsaw puzzle that sits on the table half-finished inviting the passer-by to discover more of the picture. (p. 180)

Each of the critical aspects of an object of learning contributes to the understanding of the whole, yet the aspects also bear some relationship to each other. Thus, to fully understand an object of learning, one must be able to discern how the different aspects are related to each other and how each aspect is related to the whole (Chik and Lo, 2004). Students will learn better if the teacher is able to consciously structure the teaching in such a way as to bring out the structure of the contents with clear part-part relationships and part-whole relationships, to facilitate students' discernment of these during the lesson. A more detailed account can be found in Marton and Tsui (2004).

A pedagogy based on variation

Children have to learn to be discerning, and they do not necessarily discern naturally what they need to discern. As Bransford et al. (2002) aptly point out,

> A common misconception regarding "constructivist" theories of knowing (that existing knowledge is used to build new knowledge) is that teachers should never tell students anything directly but, instead, should always allow them to construct knowledge for themselves. This perspective confuses a theory of pedagogy (teaching) with a theory of knowing … teachers still need to pay attention to students' interpretations and provide guidance when necessary. (p. 11)

We believe that teaching should be a conscious structuring act, as the responsibility falls on the teacher in designing learning experiences that can bring about the discernment needed. Research studies undertaking this view in the past few decades (e.g., Säljö, 1975, on text comprehension; Hounsell, 1984, on essay writing; Laurillard, 1995, on problem-solving) show that, even in specified situations, qualitative differences in learning were observed. The qualities of such learning were related to the *patterns of variation* that the learners experienced with respect to the same elements of the situations, i.e., what are experienced as varying and what are not. After observing numerous lessons in the Shanghai area for many years, Gu (1991) also arrived at the same conclusion empirically, that good classroom practices are characterized by the use of appropriate patterns of variation in dealing with the objects of learning. Similar observations were made and have been recently reported in a number of studies comparing pairs of lessons with similar teaching contents in Hong Kong (Marton and Morris, 2002; Marton and Tsui, 2004). Based on the findings of these studies, Marton and Morris (2002) make the following claim about the critical conditions in classroom learning:

> The most powerful differences in how the objects of learning are dealt with are: (a) what aspects are focused on, (b) what aspects are varied simultaneously, and (c) what aspects remain invariant or constant. (p. 133)

In 2003, Marton and Runesson identified four patterns of variation that were commonly found in the lessons: *contrast, generalization, separation,* and *fusion.* Subsequently, in an advanced workshop led by Professor Ference Marton, for the research team on Learning Study at the Hong Kong Institute of Education, in November 2004, the team came to the consensus that, instead of regarding *contrast, generalization, separation,* and *fusion* as patterns of variation, it would be more appropriate to consider them possible functions that may be served by the same patterns of variation which are related to a specific object of learning. For instance, when we want to teach a child the concept "brown," we expose him or her to the experience of some other colours that are not brown (e.g., red, yellow). Here, the pattern of variation is produced by varying values of the same aspect. This enables the child to *contrast* brown with other colours and differentiate what is (i.e., example) from what is not (i.e., non-example) "brown." Then, by focusing the child's attention on what is common among different values of "colour," a dimension of variation (colour) is opened up, and colours like brown, red, and yellow are recognized as values on this dimension of variation. Thus, the same pattern of variation also serves to *separate* the abstract concept "colour" (the dimension of variation) from other aspects and hence makes possible the discernment of the concept.

However, in order for the child to fully understand the concept "brown," he or she should also experience its varying appearances ("brownness") in specific cases, such as brown chairs, brown tables, brown bookshelves, etc., to
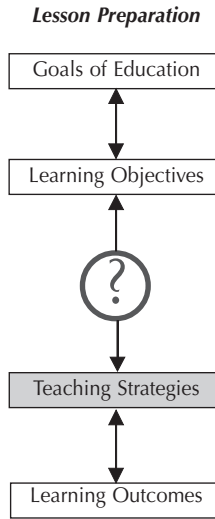
be able to *generalize* from those cases the "brownness" and distinguish it from other irrelevant aspects (e.g., "chairs," "tables," "bookshelves"). Thus, the pattern of variation, which consists of different appearances of a specific feature in a number of cases, makes it possible for the learner to make *generalizations* of the invariant principle or aspect to be discerned.

An understanding of a phenomenon or an object sometimes depends on the simultaneous awareness of several critical aspects and how these aspects relate to each other and to the phenomenon or object as a whole. The pattern of variation that involves simultaneous variation in the dimensions of variation that correspond to the critical aspects makes it possible for *fusion* to take place. For example, in order to understand what determines price, the learner must be able to experience simultaneously the variation in both the supply and demand of the same commodity, in order to be able to discern that the price of a given commodity is determined by the relative magnitude of changes in both the supply and demand of that commodity.

Therefore, different patterns of variation can be created, in different combinations and structures, to bring about different desired learning outcomes by having the learner to focus on certain aspect or aspects of the object of learning. This can be achieved by varying a certain aspect or aspects simultaneously while keeping certain aspects invariant.

Pang's (2002) study, which compared two groups of experienced teachers working together systematically on the same object of learning, revealed that the group with the specific theoretical grounding in the Theory of Variation was considerably more effective in bringing about the intended learning outcomes than the group without that explicit grounding (p. 137). If variation is the key to discernment, it should be a useful tool for structuring teaching so that the object of learning can be encountered in a particular way.

We do not advocate any particular method of teaching, and we fully acknowledge the importance of using innovative teaching methods to create learning environments that not only serve to motivate students to engage in learning but also are used as a vehicle for developing students' capabilities in the general aspect of certain objects of learning (such as being cooperative in carrying out an experiment in a group). However, we wish to point out that a gap (as represented by the dotted line in Figure 2.1), which exists in lesson preparation as practised by many teachers in Hong Kong and elsewhere, needs to be filled. There is currently too much emphasis on teaching methods, so that educational reforms are centred on innovations in teaching methods, e.g., the activity approach, project learning, problem-based learning, etc., without making reference to the content or subject matter upon which such capabilities can be built.

Lesson Preparation

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      ┌──────────────────────┐
      │  Goals of Education   │
      └──────────────────────┘
                 ↕
      ┌──────────────────────┐
      │  Learning Objectives  │
      └──────────────────────┘
                 ↕
              ( ? )
                 ↕
      ┌──────────────────────┐
      │  Teaching Strategies  │
      └──────────────────────┘
                 ↕
      ┌──────────────────────┐
      │  Learning Outcomes    │
      └──────────────────────┘
```

Figure 2.1 The gap that exists in lesson preparation needs to be filled

We would argue that capabilities can only be built upon specific objects of learning. Therefore, before we can start talking about what teaching methods or strategies to employ, we need first of all to ask ourselves the following questions:

- In what ways would the targeted learning outcome(s) contribute to the overall goal of education?
- What kinds of object of learning will best help us to achieve the targeted learning objective?
- How is this object of learning positioned within the overall conceptual framework for that subject matter? What kinds of pattern or relationship must be discerned in order for students to transform the factual information they have acquired into deep understanding and usable knowledge?
- What are the critical aspects of the object of learning, as reflected by students' prior understanding, knowledge, and beliefs? How can this knowledge be used as a starting point for dealing with students' learning difficulties and to help them in building new knowledge and developing deeper understanding of the object of learning?
- What kinds of pattern of variation can best be used to help students discern the critical aspects and their relationships?

Only after we have thoroughly considered the above questions would we be asking questions like the following:

- Which teaching approach would best help to achieve the intended learning outcomes?
- What methods or teaching strategies should be employed to help build a relevance structure for the students, so that all students will find what they are learning meaningful, and so are motivated and engaged?
- What methods or teaching strategies are required to facilitate the students in achieving the general aspect of a certain object of learning that is important for the learning?
- What kinds of activity would best bring out the patterns of variation to help the students learn?
- What kind of interaction in class is required, so that feedback on students' learning can be obtained during the lesson?
- What kinds of assessment can be used to provide feedback to both the students and the teachers about the effectiveness of teaching and the quality of the learning that are taking place or have taken place? Figure 2.2 summarizes the stages that we consider important in the planning of a lesson, and how the Theory of Variation helps to improve teaching and student learning outcomes.
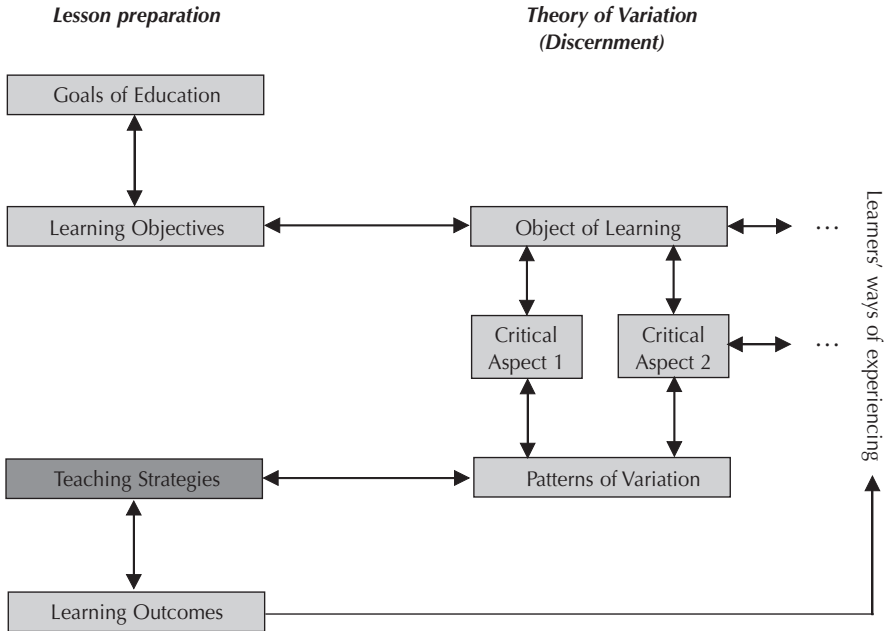
Figure 2.2 The important stages in the planning of a lesson and the contribution of the Theory of Variation to the improvement of teaching and learning

Conclusion

In the previous sections, we explained the conceptual framework we use for understanding learning, and our approach to catering for individual differences. We try to ascertain/discover the differences in the ways our students experience or think about what they are supposed to learn. From these differences, we try to identify the critical aspect(s) for the learning, thereby helping our students to learn more efficiently. In other words, we try to cater for individual differences by making use of these differences, i.e., by focusing on the students' differing perspectives as the points of departure rather than assumed difference in ability.

Knowing the critical aspects in order for planned variation to take place is not a simple task. It requires a focus on both the object of learning as well as the specific difficulties that students need to overcome in learning what is intended for them. However, our experience in teacher education tells us that good and experienced teachers are, in fact, not short of such knowledge. At the same time, it seems that such knowledge can be partial and not reflected on, let alone shared with other teachers. We try to bring about such sharing among teachers of what they know about student learning needs or difficulties by using what we consider to be a powerful tool — Learning Study. Learning Study is inspired by the Japanese Lesson Study (Stigler and Hiebert, 1999) and is a systematic process of enquiry into teaching and learning, which employs action research methodology and has the improvement of teaching and learning at its core. It takes the concerted effort of teachers, researchers, and academics working collaboratively and going through many cycles of action research for improvement, before we can get close to solving the problem of catering for individual differences. We explain our methodology in detail in Chapter 3.

We believe that learning occurs when we experience *something* in new and meaningful ways, so that the new knowledge acquired can be applied appropriately to new situations, and to illuminate new phenomena. That is to say, learning has its particular content focusing on a phenomenon or an object, and has to be related to the learners' existing ways of seeing the object concerned. To cater for individual differences, we believe that teachers should do the following:

1. Carefully select worthwhile objects of learning.
2. Identify variation in students' understanding of the intended object of learning and corresponding critical aspects that present difficulties to students' learning.
3. Plan learning experiences to help students focus on these critical aspects by making use of appropriate patterns of variation.

There are limitations to any theory, and we wish to point out that the learning Theory of Variation does not provide us with insights about the exact teaching strategies to employ. That is why we advocate that teachers and academics (researchers or teacher educators) should come together in cycles of Learning Studies, where they can contribute their expertise in content knowledge, pedagogical knowledge, as well as pedagogical content knowledge, to the planning process. A review of the literature on the teaching of that particular topic would also be very important input to ensure the quality of the resulting lesson.

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