# Chapter 10
# PBL Tutorial Linking Classroom to Practice: Focusing on Assessment as Learning

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The demand for a qualitative transformation of university education has drawn attention to *problem-based learning* (PBL) as a form of active learning focused on solving problems. PBL has been incorporated into a range of academic disciplines, and some universities have even introduced it across the curriculum as common education. On the other hand, some medical universities that were early adopters have now abandoned PBL, which would suggest that there are some key issues to be addressed not only in terms of this particular learning mode but also PBL functionality.

In this paper we discuss the implementation of PBL at the Niigata University Faculty of Dentistry and the development of the *modified triple jump* as a means of directly assessing problem-solving ability. We observe that, in order for PBL to have an educational effect, learning outcomes need to be properly assessed, and the assessment process needs to comprise more than just *assessment of learning*. It should also be a learning experience for the student—in other words, *assessment as learning* (Earl 2003).

## Two PBLs

In recent years, universities have been required to effect a qualitative transformation. A December 2008 report from the Central Council for Education entitled *Towards Building Undergraduate Education* identified a number of expected learning outcomes from undergraduate education, regardless of students' particular

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departments or majors. These comprised not only knowledge and understanding, but also generic skills such as the capacity for logical thinking, problem-solving ability and communication skills; attitudes and dispositions such as teamwork, leadership and social responsibilities as a citizen; and integrative learning experience and creative thinking. In other words, universities were called upon to develop students acquiring not only knowledge but also the ability to use it. A further CCE report released in August 2012 was called "Towards a Qualitative Transformation of University Education for Building a New Future: Universities Fostering Lifelong Learning and the Ability to Think Independently and Proactively," representing a more specific drive for a qualitative transformation in university education in which active learning became a key term.

One form of active learning that has come under the spotlight as part of this drive is PBL, which focuses on problem-solving. PBL is the abbreviation for two education methods: problem-based learning, developed in the 1960s primarily in the context of medical education; and project-based learning, developed in the 1990s primarily in the context of engineering education. In both cases, learning is designed on the basis of constructivist theory—the concept that knowledge is actively constructed by the learner—and both PBLs share a framework of activity whereby small groups engage with authentic problems, with students managing their own learning and teachers supporting this process as facilitators. In problem-based learning, however, the learning process is clearly defined and reflected in the design of activities, whereas in project-based learning, the learning process is entrusted to each specific practice (Yuasa et al. 2011).

This chapter focuses on problem-based learning, using the example of PBL implementation at the Niigata University Faculty of Dentistry to examine what is required to guide students toward deep active learning, particularly from the perspective of assessment as learning.

## PBL in Practice

### *PBL and the Curriculum*

The Niigata University Faculty of Dentistry was established in 1965 as a Japanese national university dentistry faculty, and originally comprised only an undergraduate course training dentists. In 2004, however, the Department of Oral Health and Welfare was set up to train professionals with the skills of both a dental hygienist and a social worker. The aim was to provide comprehensive services based on partnership among oral health, dentistry and welfare in order to meet the needs of a super-aged society. Today, the school comprises the Department of Dentistry and the Department of Oral Health and Welfare. The Department of Dentistry is a 6-year course, and the Department of Oral Health and Welfare four years, with 40 students in each year of the former and 20 in the latter. The basic philosophy of

both departments is that undergraduate education comprises the first stage in life-long learning as an oral health care provider, with the focus accordingly placed on developing problem-solving abilities, training professionals who are able to develop their own expertise in their subsequent learning at graduate school and out in society. To that end, we added "generic skills" to "knowledge and understanding", "professional expertise", and "attitudes and dispositions" as the learning outcomes we expect students to acquire by the time they graduate, and as of 2004—in other words, as of the time that we established the Department of Oral Health and Welfare within the Faculty of Dentistry—we introduced PBL into the curriculum to develop students' problem-solving abilities within the context of dental education (Ono et al. 2006, 2011).

PBL at the Niigata University Faculty of Dentistry follows the formula developed by the Malmö University Faculty of Odontology in Sweden (Rohlin et al. 1998), where classes take the format of students working through problems in groups of seven or eight facilitated by a tutor. First, facts are identified from cases—*scenarios*—and students discuss questions and thoughts arising from those facts. Students then determine what knowledge they lack to resolve their questions and to test their hypotheses, and set learning tasks. Outside class, students then individually undertake their learning tasks. They reconvene a week later to consider as a group the results of their research, discuss whether their hypotheses were valid, and solve the problem. In PBL, therefore, learning is pursued as a three-step process of group learning in class, individual learning outside class, and then again group learning in class (Fig. 10.1). Because students learn through a process of solving problems derived from scenarios in collaboration with a group, PBL results in the acquisition of a body of deep knowledge and understanding integrated from a wide

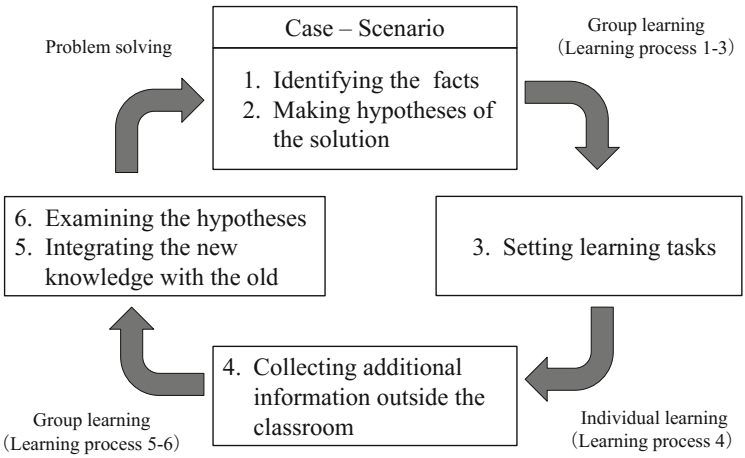


**Fig. 10.1** PBL cycle

range of disciplines, and development of (a) the ability to analyze and solve problems, (b) interpersonal skills, and (c) a desire to continually learn (Barrows 1998).

PBL is used in the fifth year in the Department of Dentistry, and from the second to the fourth year in the Department of Oral Health and Welfare. Here we examine the PBL curriculum in the Department of Oral Health and Welfare.

The academic year comprises two semesters of 15–16 weeks each. The semester is taken as one large basic unit for learning, with key learning content for each semester determined and each semester including between five and 16 related courses. The learning for each semester is chosen based on current social conditions, and is structured from the simple to the complex, or from oral science to subjects related to individuals' health and the wider social context (Table 10.1). Within each semester too, with the exception of the first year, classes are not necessarily conducted in the Japanese university's traditional format of one class per week throughout the semester; rather, the order in which each subject is taught is determined by the learning content—a modular curriculum, in other words.

Classes are taught through a suitable combination of PBL, lectures, practicums and seminars. In the first semester in the first year, the students acquire learning skills and the ability to think logically in a 'Study Skills' seminar. Then, from the second year until graduation, PBL is used to help students acquire integrated knowledge and boost their problem-solving abilities and interpersonal skills. From early on after university entrance, students are also continually provided with the opportunity to interact with actual patients, fostering their professional identity as oral health care providers along with the appropriate attitudes. PBL, lectures, practicums and seminars are organically linked, ensuring that the learning content of each is related. As much as possible, classes with related content are held over the same period, regardless of their form, so that students can put the model that they have learned in class immediately into practice or observe what they have learned in a clinical or welfare context.

The year's curriculum for second-year students is shown here as a specific example (Fig. 10.2).

The first semester of the second year serves as students' first real introduction to professional education. The emphasis is on students understanding and implementing PBL, grasping the actual roles and duties of dental hygienists and social workers, understanding the structure and functions of the mouth, understanding the pathogenesis and pathology of oral diseases, and learning infection control measures. In 'Introduction to PBL,' the first course in the first semester, students study the PBL learning method, and then apply the PBL method to their learning in 'Human Body Mechanism' and 'Oral Science.' In 'Early Exposure to Clinical Practice IIB,' students go off-campus to general hospitals, public health centers, social welfare offices, and special nursing homes for the elderly, etc., for the experience of interacting with patients/users and staff at these facilities. In the second semester, students use the knowledge and skills acquired in the first semester to tackle PBL subjects such as 'Dental Hygiene' and 'Dental Hygiene Practice I,' learning how to diagnose, treat and prevent mild oral diseases. The

**Table 10.1** Core learning in each semester

| | First semester | Second semester |
|---|---|---|
| First year | **Higher education study skills and personal growth** | |
| | Acquisition of study skills and autonomous learning attitude | |
| | Liberal arts cultivation | |
| | Interaction with a variety of people, including patients/users | |
| Second year | **Oral health promotion and self-awareness as an oral health care provider** | **Diagnosis, treatment and prevention of mild oral diseases** |
| | Understanding the structure and functions of the mouth | Theory and practice of diagnosing, treating and preventing mild dental caries and periodontal disease in ordinary adult patients |
| | Understanding the importance of oral health | Theory and practice of individual dental hygiene guidance |
| | Learning how to control infection | Acquisition of basic assistance techniques of conservative dentistry |
| | Self-awareness as an oral health care provider | |
| Third year | **Diagnosis, treatment and prevention of advanced oral diseases** | **Understanding and dealing with the elderly and disabled** |
| | **Basic understanding of social welfare and social security** | |
| | Theory and practice of diagnosing, treating and preventing advanced dental caries and periodontal disease in ordinaly adult patients | Understanding and dealing with the physical and mental characteristics of the elderly and disabled |
| | Theory and practice of group dental hygiene guidance | Acquisition of basic assistance techniques of oral surgery and prosthodontics |
| | Acquisition of basic assistance techniques of pediatric dentistry and orthodontics | Understanding of welfare for children, the elderly and the disabled |
| | Understanding of social welfare and social security | |
| Fourth year | **Practical oral health promotion from the perspectives of the individual and society** | |
| | Synthesis of knowledge, skills and attitudes through clinical practice and practice in social welfare situations | |
| | Understanding and practice of community dental health services | |
| | Understanding of the medical care provision system and the medical insurance system | |
| | Increased awareness as an oral health care provider | |

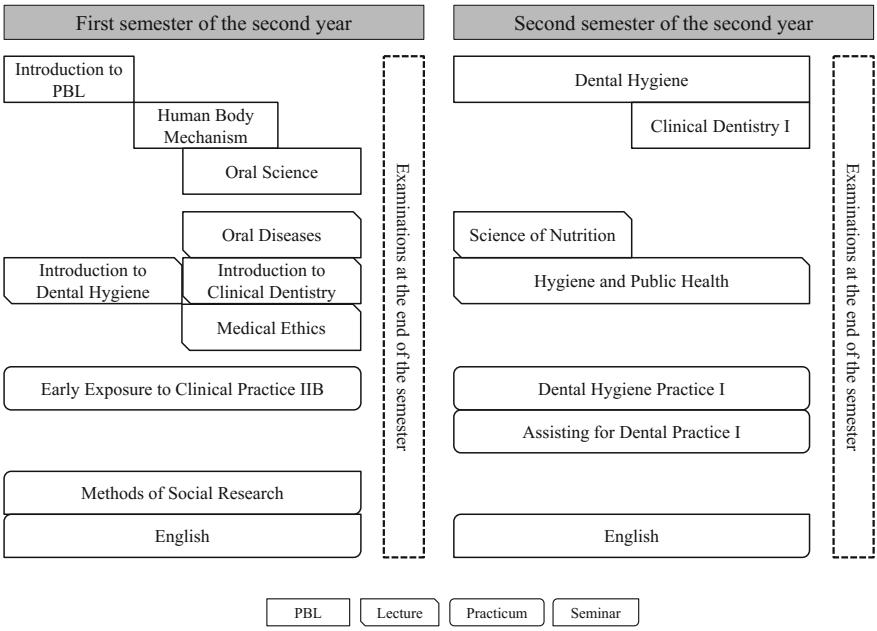


**Fig. 10.2** Curriculum at year level

academic year basically comprises two semesters, but because subjects are organized with a view to facilitating student learning, the result could also be described as a loose four-quarter structure.

Next we turn to the weekly curriculum, using the example of the first semester of the second year (Fig. 10.3).

The Monday afternoon subject is 'Oral Science' PBL (Fig. 10.4), and in the fourth period, students identify their problem, generate hypotheses and set learning tasks. They use periods when they have no classes or once they have gone home for self-study and collecting information on learning tasks from the Internet and from technical books. 'Oral Science' on Wednesday afternoons is a seminar on a topic related to the learning tasks. During 'Oral Science' in the third period on alternate Mondays, students use their newly-acquired knowledge to solve their problem (Fig. 10.5). In the fourth period, students tackle the next scenario, launching the next learning cycle.

## *Scenario Design*

Scenarios are designed by teachers based on actual cases. The purpose, objectives, and desired learning tasks are laid out for each scenario. The important thing is for students to consider learning tasks and the order in which these will be addressed,

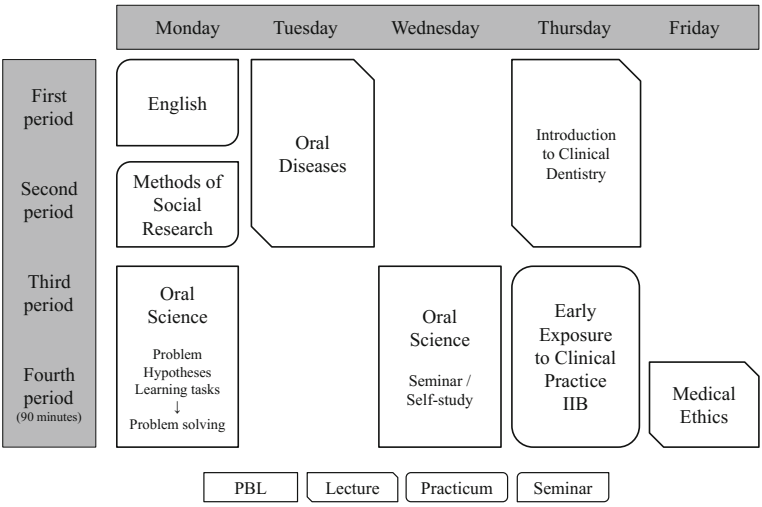


**Fig. 10.3** Curriculum at week level

**To extract or not to extract, that's the question.**

Ms. Ayako Suzuki is a second year student at Niigata University dental school. She has been going to the dentist since two months ago. One day, the dentist told her looking at her panoramic radiograph. "Hmm. You've got impacted wisdom teeth of the mandible and why don't you extract those on the next visit?" She knew that she had it on the right hand side because she could see a part of the tooth crown just a little bit behind the second molar but did not realize regarding the left one. She has never experienced any complications nor symptoms with these teeth though. She recalled that a senior of her school told her that the extraction of impacted wisdom tooth might be very tough and risky.

**Fig. 10.4** An example of the scenarios in the course 'Oral Science'

so that through their accumulated learning from the various scenarios students ultimately achieve the educational objectives for the subject or come to comprehend the disease concept. For example, to help students understand a particular disease, we start by creating a concept map, considering what parts of that concept map we want students to master and in what order, seeking to put together scenarios that will embed the new knowledge within the student's existing cognitive structure and progress learning in such a way that students naturally recognize the disease concept. Other key points in scenario design are authenticity (whether the scenario is frequently encountered in general dental practice), whether the level of difficulty is appropriate for an undergraduate curriculum, whether integrated learning through multiple basic and clinical subjects is possible, whether learning tasks are far too numerous for the amount of time available for self-learning, and whether efforts have been made to incorporate audio and visual media to stimulate student interest.

**Group learning in the fourth period on Monday afternoon**

1. Students are supposed to identify the facts from the scenario. Then, they discuss the questions that they cannot answer precisely and problems they should solve based on those facts.
e.g.,
- Why the dentist recommends to extract the impacted wisdom teeth?
- What are the risks of wisdom tooth extraction and why?
- To extract or not was a very difficult decision for Ayako to make.

2. Students are supposed to answer the questions based on their own knowledge and experience through a group discussion and develop hypotheses and solutions.
e.g.,
- Oral microbial might cause the inflammation.
- I've heard that extraction of wisdom tooth of the mandible might result in paresthesia of the lower lip.
- When Ayako would understand necessity and risks of the extraction precisely, she could decide what she should do.

3. To proof the validity of the hypotheses and solutions they developed, students are supposed to set up some learning tasks.
e.g.,
- Etiology, symptoms and spread of oral inflammation.
- Mandibular nerve tracts and those names.

**Individual learning outside class**

4. Students are supposed to collect information on the learning tasks from the Internet and from technical books.

**Group learning in the third period on next Monday**

5. Each student is supposed to bring their searched results back to their group and try to improve their understanding through the discussion.
e.g.,
- Was the information reliable?

6. Students are supposed to verify their hypotheses and solutions.
e.g.,
- Should Ayako accept the extraction of her wisdom teeth?
- What kind of information is missing for her to decide to extract or not?

**Fig. 10.5** PBL exercise in the case of the scenario in Fig. 10.4

## *Facilitator Development*

Because PBL is based on small-group learning, it requires numerous teachers, and all Faculty of Dentistry teachers and graduate students (not only from the Department of Oral Health and Welfare, but also from the Department of Dentistry) serve as facilitators. Having everyone participate, whether they specialize in basic or clinical subjects, or whether they are professors, associate professors, lecturers or assistant professors, reduces the individual load, and sharing the load equally amongst those staff makes it easier to gain their cooperation. We have a range of academic staff, with some focused on research while others emphasize clinical practice, for example, but serving as a facilitator is regarded as the minimum educational contribution in the Faculty of Dentistry, and is also scored highly as an educational achievement when it comes to tenure reviews. What this also means, however, is that the facilitators participating in each group change frequently, drawing complaints from the students.

Facilitator development and teaching continuity are therefore major issues. We hold a facilitator briefing at the beginning of every academic year, explaining the facilitator's role, how PBL works, and key points in guiding students, and this information is also provided in the form of a facilitator guide. The content of group learning is also recorded each time and stored in the facilitator guide so that the next

facilitator will know what was discussed at the last group learning session. In addition, because, for example, a welfare-related scenario might be difficult for a facilitator who is not a welfare expert to understand, the facilitator guide also contains scenario commentaries as a teaching reference.

In 2004 when PBL was first introduced, we held a multi-day training workshop for all academic staff, but we reached the conclusion that the ability as a facilitator can ultimately only be developed in the classroom, so these workshops are no longer held. Facilitator development through actual practice appears to be more effective, such as having new academic staff work in tandem with experienced facilitators in the classroom, or setting up opportunities to discuss teaching methods among facilitators after they have participated in group learning. Almost 10 years since the introduction of PBL, we now also have graduate students who have come through PBL-based undergraduate training participating as facilitators, and they appear to be bringing their own undergraduate experiences and reflections with them.

## How Students View PBL

To fully grasp students' views of PBL, a survey was conducted of Department of Oral Health and Welfare graduates (Ono et al. 2011).

The survey targeted a total of 56 students: 17 graduating from the first class in 2007, 20 graduating from the second class in 2008, and 19 graduating from the third class in 2009. Questionnaires about the curriculum and about classes were handed out in March to fourth-year students who had completed their graduation assessment. The survey gathered students' views using a four-point scale multiple-choice format along with free-response questions, looking at satisfaction with the curriculum as well as the meaningfulness of a PBL-based curriculum.

The purpose of the survey was explained to students, who were also told that they were free to choose whether or not they cooperated in the survey. A total of 50 students (89.3%) consented to participate: 17 from the first class (100%), 18 from the second (90.0%) and 15 from the third (78.9%).

In terms of satisfaction with the curriculum, responses were generally favorable, with an average of 70.0% of students across all three classes giving a positive assessment ("satisfied" or "somewhat satisfied"). The reasons they gave included: "The PBL curriculum," "The small-group format," "Because the program covered both oral health/dentistry and welfare," "The curriculum allowed plenty of time for self-study," and "The curriculum focus wasn't on national exams." Some students also expressed dissatisfaction, such as "There weren't enough lectures," "Some years were much busier than others," and "Not enough was done to prepare us for national exams."

Overall, students found active, integrated and experience-based learning to have been valuable, and an average of 82.0% of respondents—88.3% from the first class, 77.8% from the second, and 80.0% from the third—agreed that PBL as the focus of

the curriculum was "valuable" or "somewhat valuable." Many comments were made to the effect that the PBL focus established the habit of self-learning and boosted problem-solving abilities and interpersonal skills, such as "I acquired the habit of researching and studying by myself," "I acquired the capacity to engage with an issue," "I have retained what I learned," and "Engaging in discussion made me more proactive."

In addition, as noted earlier, the Department of Dentistry also brings in PBL in the fifth year, and fifth-year student assessments in 2004 and 2005 saw 83.7 and 84.6% of students respectively finding the experience "valuable" or "somewhat valuable" (Ono et al. 2006). A survey of 2005 fifth-year students on completion of their year of dental clinical training following graduation saw that percentage hold at a high 79.1%, with comments including "Learning to engage in my own research and study was useful when faced with problems in a clinic," "Learning through self-study helped me to retain the information, and I experienced good recall during training," and "I learned to work with others" (Ono et al. 2009).

Because students had gone through primary and secondary education with the knowledge transmission method, there was initially concern that they would struggle with speaking up in a group-based learning context (Maeda et al. 2003), but many students in fact embraced PBL. A PBL literature review notes that there are also reports of a strong student preference for PBL over lectures (Albanese and Mitchell 1993).

## Assessment of PBL Learning Outcomes

### *The Ability Assessment Issue*

The above 50 graduates from the Department of Oral Health and Welfare were given a questionnaire on the learning outcomes expected by the time of graduation —more specifically, levels of achievement in 29 items from the four criteria of knowledge and understanding, professional expertise, attitudes and dispositions, and generic skills—with respondents choosing from among the four-point scales of "understand," "understand somewhat," "don't really understand," and "don't understand." While there were some disparities between graduating classes, a high overall ratio of students responded that they either "understand" or "understand somewhat." More than 80% of students (inclusive of those who responded "somewhat") felt that they could "independently identify the problem, gather, analyze and integrate the necessary information, and solve the problem" (Ono et al. 2011).

Assessment of learning outcomes can therefore include indirect assessments like the one where students themselves are asked what they think they can do. However, there is a question of the extent to which the results of such indirect assessments actually reflect student abilities. Direct assessments that require students to

demonstrate what they can do are clearly essential. At the Niigata University Faculty of Dentistry, student knowledge and understanding has been assessed through written examinations at the end of the semester, while problem-solving ability and interpersonal skills are evaluated by the facilitator during group-based learning sessions. However, there was some doubt as to whether proper assessments could be made when one facilitator was simultaneously evaluating seven or eight students while also providing learning support. Moreover, it was impossible to evaluate students who were silent during group learning. As introducing PBL but at the same time being unable to properly assess the abilities developed through that learning might even reduce student motivation, a new assessment method had to be developed as soon as possible, not least to ensure alignment between ability goals and assessments.

As an aside, the pass rate for the national dental hygienist examination from the first through the third class was 98.0, 85.0% in the case of the national social worker examination, judging from which students would generally appear to be acquiring the basic knowledge required of dental hygienists and social workers.

## *Development of the 'Modified Triple Jump'*

The triple jump is an assessment method proposed by McMaster University in Canada in 1975 for assessing problem-solving and self-learning abilities in PBL (Blake et al. 1995). It comprises a three-step exercise undertaken by the individual student and the tutor in the same format as the usual PBL learning process, whereby the tutor replaces the Steps 1 and 3 of group learning and assesses the individual student accordingly. More specifically, in Step 1, the student reads the scenario and identifies the problem from the facts given in the scenario, proposing solution strategies. The student can ask the tutor for additional information that the student considers necessary, and the tutor also prepares additional information for the scenario. In Step 2, to test his/her solution strategies, the student goes off to the library to gather reliable information and engage in self-directed learning. In Step 3, the student goes back to the classroom and integrates the knowledge gained through Step 2 with their existing knowledge, explaining his/her solution to the tutor.

The validity of triple jump assessment, particularly face validity, is regarded as high in that the assessment mirrors the usual PBL format. Moreover, having various experts develop a triple jump scenario together and/or subjecting the material to expert scrutiny is said to ensure high content validity. However, reliability is considered to be generally low due to subjectivity in the assessment process, the absence of peer review of the exchange between the student and the teacher, the possibility of the teacher missing the student's explanation in the course of an oral exchange, the quality of assessment materials, the student's personality (e.g., extroverts or introverts), and the assessor's skill level (Mtshali and Middleton 2011). In addition, because the triple jump requires time for the student to engage in self-directed study, assessment is also time-consuming, imposing a considerable

burden on the teacher (Newman 2005). Consequently, the triple jump tends to be paid little attention these days, and is used at few universities. However, because no assessment method has yet been found to replace the triple jump that is valid, reliable and feasible, in 2012 we began looking at how the triple jump could be modified with the aim of developing a new PBL assessment method. We placed particular emphasis on developing a formative assessment at a pre-determined point in the process, and on making assessment a meaningful experience for students.

As with the original triple jump, Step 1 of the modified triple jump requires the student to identify a problem from a scenario, propose solution strategies and identify learning tasks, but that process must be written down on a worksheet within 60 min. In Step 2, the student has one week to not only undertake the necessary research but also consider the solution strategies in the light of his/her research results and formulate a solution, with that process again noted on a worksheet (Fig. 10.6). Compared to Steps 1–3 of the original triple jump, the modified triple jump assesses Steps 1 and 2 from worksheets rather than from an oral exchange, with the use of a rubric in the assessment. In Step 3 of the modified version, the scenario is recreated through a student-teacher role play, with a rubric again used to assess the process through implementation of the solution. The whole process including feedback on assessment results is usually concluded in 15 min (Fig. 10.7). Introducing worksheets into Steps 1 and 2 enables multiple students to be examined at the same time, and while it takes time to assess the worksheets, the teacher is confined to the assessment site for a far shorter period. The use of a rubric for Steps 1 and 2 and then again for Step 3 promises to boost assessment reliability. In fact, as we will explore below, the generally high level of reliability amongst assessors when students were assessed using the two rubrics suggests that the modified triple jump has resolved the problem of assessment reliability that has traditionally plagued the triple jump (Ono et al. 2014).

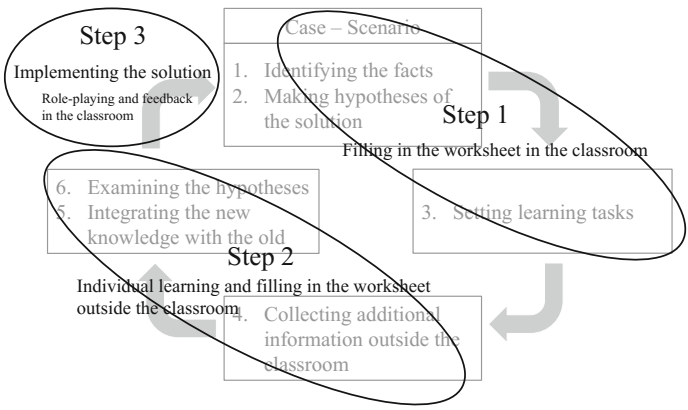


**Fig. 10.6** PBL process and steps of the modified triple jump

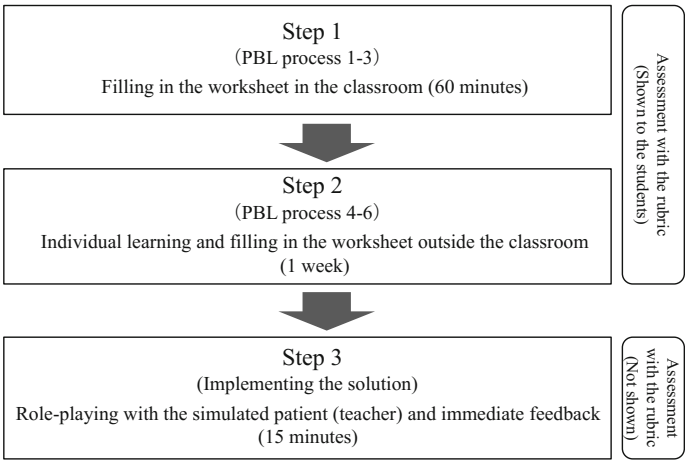


**Fig. 10.7** Structure of the modified triple jump

## *Introduction of the Modified Triple Jump into the Curriculum*

In the first semester of 2013, a modified triple jump assessment was conducted of 24 second-year students from the Department of Oral Health and Welfare.

As noted earlier, the subjects for that semester are 'Human Body Mechanism' and 'Oral Science,' so we created a new scenario related to that learning content for the triple jump assessment (Fig. 10.8) as well as a worksheet for Steps 1 and 2 (Fig. 10.9), the rubric used to evaluate worksheet responses (Table 10.2), and the rubric used in Step 3 to evaluate the role play (Table 10.3). Because students can ask the teacher partnering them in the role play for additional information they think necessary in implementing their solution, we also prepared that additional information.

The rubric for Steps 1 and 2 tracks the PBL learning process across the six stages of (1) identifying the problem, (2) conceiving solution strategies, (3) setting learning tasks, (4) learning results and resources, (5) examining solution strategies, and (6) proposing a solution—with those stages from identifying the problem through to setting learning tasks equating to Step 1 and learning results and resources through to proposing a solution equating to Step 2. Three levels of descriptors are provided, but because those students not satisfying Level 1 requirements are assessed as Level 0, there are effectively four levels. Level 3 is the level which the university expects students to have reached by the time they complete their education in the Department of Oral Health and Welfare—in other words, fourth-year students. This is a generic and longitudinal rubric which can be applied to a range of assessment tasks (Matsushita 2012).

**Am I a failure as a dental student?**

You're a second-year student at the Niigata University Faculty of Dentistry. Your specialist subject classes began in April, and you're studying anatomy and physiology. However, you're still not used to the new PBL method, while the subject matter also seems to have suddenly become much more difficult, so at the moment you're battling with both the workload and anxiety.

One day, Akira Sato, a friend you met through a university club who is currently a third-year student at the Engineering Faculty, comes up to you with a swollen left cheek. Apparently, he had a wisdom tooth on the left side of his lower jaw extracted three days ago at the nearby dental clinic, but his lower lip still feels paralyzed on the left side, so he can't even tell if he has a breadcrumb stuck to his lip. He also hasn't been able to open his mouth very wide since the operation and the left side of his throat hurts when he swallows, so he's having trouble eating.

Because you're a dental student, he's hoping that you can tell him why this is happening, but you don't know how to answer him so you say nothing. He looks worried and says, "Maybe next time then," going off to talk to another friend. Watching him walk away, you kick yourself that as a future dental hygienist you couldn't at least offer a few words of advice or sympathy.

**Fig. 10.8** Modified triple jump scenario

**Step 1**
1.1 List the facts presented in this scenario. Use circles and arrows to indicate how these facts relate to each other.
1.2 Based on those facts, describe the problem in this scenario, and explain why it is a problem.
2. Determine your goal (what you hope to achieve) in relation to the problem, and describe your solution strategy (what you will do to achieve that goal). Explain the thought process that produced your solution strategy, linking it to your learning and experience so far.
3. Identify what knowledge and information you will need to solve the problem, and explain why that learning is necessary.

**Step 2**
4. Describe your learning results and note your information sources (technical books and other publications you have quoted, websites, etc.)
5.1 Consider the effectiveness and feasibility of your solution strategy. If you need additional knowledge and information for that purpose, please undertake that additional learning.
5.2 If you decide that none of your solution strategies are appropriate, go back to the work in 2 and repeat the process of designing a solution strategy and engaging in learning, adding this information in red pen.
6.1 Based on your work in 5, describe your solution to the problem.
6.2 If you need additional information from the tutor in order to implement your solution in 6.1 more effectively, note that information and why you need it.

**Fig. 10.9** Modified triple jump worksheet for Steps 1 and 2

The Step 3 rubric assesses role-play implementation of the proposed solution, and comprises the four dimensions: gathering additional information (gathering additional information and reformulating the problem), integration of information (integration of additional information and correction of the preexisting solution), sympathetic attitudes (sympathy for a partner), and communication (expressing the solution in the way that partner can grasp). Therefore it is a task-specific rubric

**Table 10.2** Rubric for Steps 1 and 2 of the modified triple jump

| Dimensions | 1. Identifying a problem | 2. Conceiving solution strategies | 3. Setting learning tasks | 4. Learning results and resources | 5. Examining solution strategies | 6. Proposing a solution |
|---|---|---|---|---|---|---|
| Explanation of dimensions | Identifies the problem based on the facts of the scenario | Determines the objective of the solution and proposes a number of solution strategies | Sets out the necessary learning tasks to solve the problem | Learning tasks undertaken using credible resources | Considers the effectiveness and feasibility of the solution strategies | Proposes a solution to the problem |
| Level 3 | Identifies and explains the problem based on the facts of the scenario, including potential causes | Proposes a number of solution strategies and explains the process by which they were developed, linking them to the student's learning and experience to date | Clearly identifies learning tasks and explains their necessity from their relation to the proposed solution strategies | Exploits and selects various available resources based on their credibility, obtaining correct information | Compares a number of possible solution strategies with regard to the effectiveness and feasibility of each, while also noting their limitations | Proposes a reasonable solution appropriate for the scenario situation and realizes that additional information is needed to effectively implement the solution |
| Level 2 | Identifies and explains the problem based on the facts of the scenario | Proposes a number of solution strategies and explains the process by which they were developed | Identifies learning tasks and explains their necessity from their relation to the proposed solution strategies, but misses some key learning tasks | Selects resources based on their credibility and generally obtains correct information | Compares a number of solution strategies with regard to the effectiveness and feasibility of each | Proposes a reasonable solution appropriate for the scenario situation |

(continued)

**Table 10.2** (continued)

| Dimensions | 1. Identifying a problem | 2. Conceiving solution strategies | 3. Setting learning tasks | 4. Learning results and resources | 5. Examining solution strategies | 6. Proposing a solution |
|---|---|---|---|---|---|---|
| Level 1 | Identifies the problem but provides an insufficient explanation | Proposes solution strategies but gives an inadequate explanation of the process by which they were developed OR proposes only one solution strategy | Learning tasks are vague, with the student failing to pinpoint what needs to be learned OR the student fails to adequately explain the necessity of the identified learning tasks | Does not pay sufficient attention to selecting credible resources, with various errors in the information obtained | Does not give sufficient consideration to solution strategies OR does not compare a number of solution strategies | Unable to propose a solution OR there are contradictions and illogical jumps between the proposed solution, learning results and/or conclusion |
| Level 0 | Students not satisfying the Level 1 criterion shall be given a zero | | | | | |
| NOTES | The problem in this scenario was that the student was unable to register the other person's unease and give a proper answer to his question. The cause was presumably that the student wasn't accustomed to PBL, and while he/she was studying anatomy and physiology, he/she had not yet | Solution strategies to this scenario are: to explain in anatomical terms the mechanism whereby wisdom tooth extraction and conduction anesthesia of mandibular nerves can cause desensitization of the lower lip; to explain in physiological terms from the | There are four key learning tasks: methods used to extract mandibular wisdom teeth (including anesthesia) and possible complications; the mandibular nerve tract and the area it supplies; the spread of inflammation and the regional anatomy (muscles | The various available resources include academic papers, technical books, textbooks, experts and the Internet | If all the proposed solution strategies are deemed inappropriate and the students repeat the learning process, they should be assessed including the socond round of learning (indicated in red) | The solution for this scenario is for the student to expain from a specialist perspective the possible causes of desensitization of the lower lip, trismus and odynophagia occrring after wisdom tooth extraction, while displaying sympathy at the other person's |

(continued)

**Table 10.2** (continued)

| Dimensions | 1. Identifying a problem | 2. Conceiving solution strategies | 3. Setting learning tasks | 4. Learning results and resources | 5. Examining solution strategies | 6. Proposing a solution |
|---|---|---|---|---|---|---|
| | achieved a deep understanding of the acquired knowledge | perspective of the spread of inflammation the mechanism whereby trismus and odynophagia (swallowing pain) can occur after wisdom tooth extraction; and to display sympathy at the other person's anxiety and eating difficulties | and spaces); and a sympathetic attitude | | | anxiety. In terms of additional information, students might ask about the state of the wisdom tooth, the use of conduction anesthesia, the extraction process, and the progression of symptoms |

**Table 10.3** Rubric for Step 3 of the modified triple jump

| Dimensions | 7. Implementing a solution | | | |
|---|---|---|---|---|
| | 7-1. Gathering additional information (gathering additional information and reformulating the problem) | 7-2. Integration of information (integration of additional information and correction of the preexisting solution) | 7-3. Sympathetic attitudes (sympathy for a partner) | 7-4. Communication (expressing the solution in the way that partner can grasp) |
| Explanation of dimensions | Through conversation with the friend, the student gathers the additional information needed to explain the symptoms that have appeared and, if necessary, reformulates the problem | The student synthesizes useful information in terms of explaining the causes of the symptoms that have appeared, including additional information, altering the proposed solution where necessary | The student responds with sympathy to the friend's anxiety and eating difficulties | The student explains the causes of the friend's symptoms in simple terms |
| Level 3 | Accurately gathers all the additional information needed to explain the symptoms that have appeared, including the state of the wisdom tooth, the use of conduction anesthesia, the extraction process, and the progression of symptoms | By synthesizing additional information gleaned from the friend, the student achieves a deep and flexible understanding of the symptoms from the relationship between the wisdom tooth extraction and the mandibular nerve tract, and between masticator space and the spread of inflammation caused by wisdom tooth extraction | Responds to the friend's anxiety and eating difficulties by expressing sympathy and encouragement and also answering the friend's question, indicating willingness to provide further help any time he/she can | Considers how to organize the topics based on their content and relevance and provides a simple explanation tailored for understanding |
| Level 2 | Gathers some of the additional information needed to explain the symptoms that have appeared, including the state of the wisdom tooth, the use of conduction anesthesia, the extraction process, and the progression of symptoms | By partly synthesizing additional information gleaned from the friend, the student achieves an adequate understanding of the symptoms from the relationship between the wisdom tooth extraction and the mandibular nerve tract, and between masticator space and the spread of | Responds to the friend's anxiety and eating difficulties by expressing sympathy and encouragement and also answering the friend's question | Generally manages to appropriately organize the topics, but some problems with expressions and the usage of technical terms in terms of ensuring understanding |

(continued)

**Table 10.3** (continued)

| Dimensions | 7. Implementing a solution | | | |
|---|---|---|---|---|
| | 7-1. Gathering additional information (gathering additional information and reformulating the problem) | 7-2. Integration of information (integration of additional information and correction of the preexisting solution) | 7-3. Sympathetic attitudes (sympathy for a partner) | 7-4. Communication (expressing the solution in the way that partner can grasp) |
| | | inflammation caused by wisdom tooth extraction | | |
| Level 1 | Only gathers a minute part of the additional information needed to explain the symptoms that have appeared, including the state of the wisdom tooth, the use of conduction anesthesia, the extraction process, and the progression of symptoms | Without synthesizing additional information gleaned from the friend, the student only understands the symptoms from the relationship between the wisdom tooth extraction and the mandibular nerve tract, and between masticator space and the spread of inflammation caused by wisdom tooth extraction as textual data | Merely recognizes the friend's anxiety and eating difficulties and focuses primarily on answering the friend's question | The way the topics were organized was confusing and the explanation was difficult to understand OR the student simply read out what he/she had prepared beforehand |
| Level 0 | Students not satisfying the Level 1 criterion shall be given a zero | | | |
| NOTES | Check that the student is not simply engaging in conversation but rather asking intentional questions | Assess the student on the content of his/her explanation | Assess the student from both verbal and non-verbal perspectives | Do not include elements such as speech habits, tone of voice, or conversation speed in the assessment |

dependent on the scenario (Matsushita 2012). For additional information-gathering and information synthesis, the thinking process of revisiting and revising the proposed solution based on the additional information from the role-play partner is assessed. While the process is basically the same as for Steps 1 and 2, because it is closer to a clinical situation and requires students to think on their feet, Step 3 presents a high level of difficulty.

Having explained to students the purpose and procedure of the modified triple jump, we conducted Step 1 for all students together outside ordinary class hours three months into the semester in which PBL was introduced. After Step 1, students were instructed to do Step 2 by themselves, and told when and where to submit their worksheets. We began Step 3 one week after the deadline for worksheet submission, assessing six students per day over four days, with students able to choose their examination date. Assessment of the worksheets and role plays was conducted by three teachers who had been involved in teaching students from the Department of Oral Health and Welfare in the first semester of their second year. One of the authors of this paper was a partner of the students in the role play. While the modified triple jump is a formative assessment, student participation is a requirement for sitting the semester-end examination, which comprises a summative assessment.

## *Learning Effects of the Modified Triple Jump*

To gauge the learning effects of the modified triple jump, we conducted a questionnaire survey of students on completion of Step 3. The purpose of the survey and the voluntary nature of participation were explained to students, who were also informed that neither their cooperation in the survey nor the nature of their responses would have any impact whatsoever on their grade or their promotion to the next year. The survey offered four levels of response—"Agree," "Somewhat agree," "Somewhat disagree" and "Disagree"—to eight statements: (1) The scenario was intriguing; (2) The worksheet was a useful guide in terms of approaching learning; (3) The rubric was useful for learning and reflecting on Steps 1 and 2; (4) The role-playing in Step 3 deepened my learning; (5) Feedback from the teacher during the role-playing deepened my learning; (6) The triple jump was a meaningful experience; (7) The triple jump enabled me to understand my problem-solving ability; and (8) My triple jump experience will help me with further PBL learning. At the end of the survey, students were asked to provide their views and impressions.

Of the 24 students, 23 submitted their responses, providing a response rate of 95.8%. Overall, most comments were positive, and in particular, more than 80% of students chose "Agree" in response to questions (4) and (5), while none responded "Somewhat disagree" or "Disagree." More than 60% of students chose "Agree" in response to questions (6), (7) and (8), which, including those who responded "Somewhat agree", represented a value of more than 90% (Fig. 10.10).

Having analyzed the views and impressions on the modified triple jump that were provided by 16 students, we divided these into the five categories of

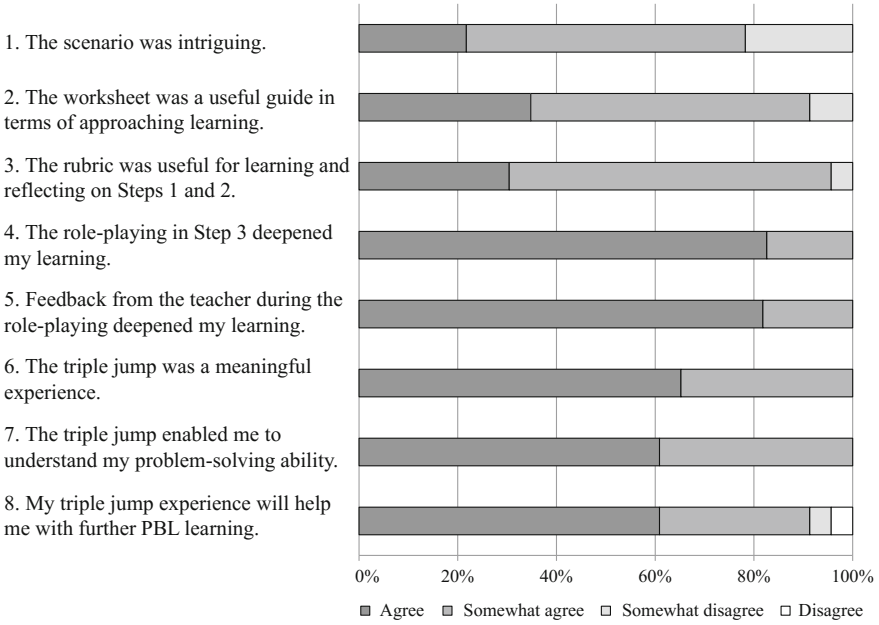


**Fig. 10.10** Learing effects of the modified triple jump

(1) nervousness and sense of achievement; (2) imagining of actual practice and deepening of learning; (3) understanding of the PBL learning method and the student's own current ability; (4) desire to participate actively in PBL in future; and (5) recognition of the triple jump as a meaningful experience. In other words, students engaged themselves in the triple jump with nervousness and a sense of achievement, with the experience imagining a sense of actual practice and deepening their learning. It contributed to their understanding of the PBL learning method and their own current ability as well as to solidifying their desire to participate actively in PBL, leading students to consider the triple jump a meaningful experience (Ono et al. 2014).

## Toward Deep Active Learning

The concept of learning outcomes began attracting widespread attention from Japanese higher education when the above-mentioned CCE report "Towards Building Undergraduate Education" labeled learning outcomes on completion of undergraduate studies as 'graduate attributes' and called for assessment of those graduate attributes. The report marked the formal introduction into Japanese higher education of outcome-based education that focuses more on what students have learned than on what teachers teach (Matsushita 2012).

PBL and other forms of active learning are effective ways of going beyond the acquisition of knowledge and understanding to develop higher-order, integrated abilities such as problem-solving ability and interpersonal skills, but direct assessment of such abilities is not easy. Even where universities introduce active learning out of a sincere desire to help students grow, they are almost inevitably faced with the thorny issue of how to evaluate learning outcomes. The method of evaluation used seems to tacitly inform the student of the teacher's real priorities (Matsushita 2007). In terms of boosting student motivation in relation to active learning like PBL, it seems important to avoid taking the easy way out with evaluation methods and instead strive to construct alignment between learning objectives and assessments.

Moreover, rather than the assessment process serving the sole purpose of assessment of learning, it should ideally also provide students with a learning experience, in other words, assessment as learning. With the modified triple jump, for example, recreating a scenario in Step 3 and tasking students with actually implementing their proposed solution on the tutor as a friend/patient helped students to understand the scenario problem as problems which they are likely to face in society and at work, engaging them in deep learning.

Advancing active learning to the level of deep active learning requires close attention not only to the curriculum, teaching materials and the learning environment, but also to assessment, and particularly to the conduct of *assessment as learning*. The modified triple jump discussed in this chapter is a method developed to assess the learning outcomes of students who have studied using the PBL method. This performance assessment combines a worksheet-based written task with a performance task in the form of a role play, and uses two different types of rubric. We hope that this exercise provides a useful reference for readers.

## Summary

- The Niigata University Faculty of Dentistry introduced problem-based learning (PBL) into the curriculum as of 2004 in order to develop students' problem-solving ability in the context of dental education. PBL is combined with lectures, practicums and seminars in semester and weekly schedules with a view to enabling students to integrate knowledge gained from lectures and other classes into their PBL to achieve deep understanding.
- The success of PBL relies not just on the curriculum but on creating authentic scenarios with an appropriate level of difficulty, as well as sharing the facilitation burden across the whole teaching team and developing their facilitation skills.
- The results of a questionnaire survey targeting graduates revealed that students liked the PBL-based curriculum, and a high proportion felt that they had achieved the expected learning outcomes. However, the lack of proper assessment of problem-solving and other higher-order integrated abilities fostered

through PBL had the potential to reduce student motivation. Developing a new assessment method was therefore an urgent task, not least to ensure alignment between learning objectives and assessments.

- We developed the modified triple jump as a means of directly assessing problem-solving ability in PBL. The modified triple jump is a performance assessment that combines a worksheet-based written task with a performance task in the form of a role play, using two different types of rubric. It brings greater reliability to the assessment of students' ability, while the introduction of a worksheet reduces the assessment burden on teachers.
- The results of a student questionnaire survey reveal that the modified triple jump is functioning not just as an assessment of learning but also as assessment as learning, with the assessment process itself providing a learning experience for students and directing them toward deep learning. Assessment has an important effect in terms of advancing active learning to the stage of deep active learning.

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