Challenge FRAP: An e-learning tool used to scaffold authentic problem-solving processes

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Challenge FRAP (Form for the Analysis of Problems), is client based public-domain authoring software that facilitates the dynamic use of scaffolding, progressive feedback to learners, and student reflection at important decision-making points. This paper reports the student use and evaluation of this eLearning tool in the context of a plant pathology course over three years. Students in a third year undergraduate course were given authentic commercially significant plant disease problems derived from industry and matched with industry clients to work through their analysis and diagnosis. The use of Challenge FRAP enabled students to work in a flexible, self-directed way with strong scaffolding support and guidance to assist them through a scholarly scientific reasoning process. The e-learning tool also enabled the teacher to gain insights into student decision-making and cognitive thinking processes and to provide feedback and guidance at crucial learning points. This paper details student perceptions of this e-learning scaffolding tool during and after their experience of using it, as well as their responses to the authentic learning context and how they believed the process influenced their learning.

Keywords: diagnosis, authentic problems, clinical reasoning, PBL, scaffolding, self-directed learning, Challenge FRAP, plant pathology

Introduction

Authentic problem-based learning (PBL) designs are known to have many benefits to students and are used widely across disciplinary areas and education sectors (Herrington, Oliver, & Reeves, 2003, p.69). The opportunity to apply knowledge and concepts through problem-solving for real world issues offers students contextualised learning and a powerful learner-centred instructional approach. Many recognise that a critical factor in successful problem-based Learning is the availability of expert tutors to guide learners through the PBL process (e.g. Hmelo-Silver & Barrows, 2006, p.21-25, Savery, 2006, p.12 Simons and Ertmer, 2006, p.297). As various constraints often limit the availability of such skilled and trained tutors, it has become increasingly important to embed instructional support and scaffolding mechanisms within the PBL design that assist learners to successfully attain their learning goals. The eLearning tool 'Challenge FRAP' provides both the educator and learner with customisable templates and a range of tools that enable better PBL design, scaffolding and learning opportunities (Stewart et al., 2007). In this paper, we provide a description of the capabilities of this software and the design of an authentic learning project that was evaluated over three consecutive years with different learner cohorts. We discuss student perceptions of this eLearning scaffolding tool during and after their learning experience and their responses to the authentic learning context and how they believed their process influenced their learning. Through describing the authoring capabilities of this software and drawing on a specific case study, this paper illustrates how this client-based public domain authoring tool has been utilised effectively to enhance problem-based learning (PBL) designs for authentic contexts.

Authentic PBL and Challenge FRAP

Problem-based learning is 'an instructional (and curricular) learner-centred approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem' (Savery, 2006, p.12). It has foundations in constructivist theories and has been shown to improve students' diagnostic skills (Schimdt et al., 1995), their retention of

content knowledge with a greater depth of understanding (Dods, 1997), and their reasoning and self-directed learning skills and strategies (Hmelo-Silver & Barrows, 2006, p.24). Solving complex authentic problems, rather than contrived problems or decontextualised learning activities, promotes high level thinking and encourages students to draw upon a range of resources that they may access as professionals. Authentic learning contextualises knowledge creation and application, and with strong scaffolding and support, can be highly motivational to learners and encourage participation (Herrington et al., 2003, p.69).

Scaffolding is a mechanism that assists learners to extend their learning into more complex or unknown areas of knowledge and knowledge application (such as real-life problems). Scaffolds may take many forms including learner guides, resources, tools and strategies that help the learner to attain higher levels of understanding. In PBL, scaffolding often takes the form of modelling, coaching and questioning to progress students through the PBL task (Hmelo-Silver, 2004, p.245), and to monitor their learning and reasoning processes. It is good practice to encourage learners to reflect on their thinking and actions and to check their own understanding so that they become more adept with problem-solving, and consequently, the level of scaffolding can be reduced. On a practical level, students are set an investigative task designed to solve a complex, ill-structured but authentic problem (Boud and Feletti, 1991, Kain, 2003). They undertake this task, in groups or individually, and report back to the tutor/ facilitator at task milestones or at completion. Reporting can take many forms from seminars through to authentic forms of communication with the client in the real world context.

When assessing a student's effort on such a task, it is important for educators to locate a well-reasoned investigative pathway that is indicative of a well-considered and scholarly approach to problem analysis, diagnosis and the proposed way forward. As such, it is beneficial when the activities completed, results and reflections are documented. This also enables the educator to provide more meaningful feedback. As a scaffolding strategy, the tutor may elect to set an example of a potential investigative pathway for the student to follow to get them started, or at least to indicate some of the common tasks expected of them.

Challenge FRAP (Form for the Recording of the Analysis of Problems) is a freeware program that provides the designer/facilitator with opportunities to track the investigative pathways, decision-making, results and reflections of learners and to create potential pathways of inquiry that the learner can utilise, change or extend. It enables the designer/facilitator to use a variety of scaffolding mechanisms, provide progressive feedback and promote student reflection at key decision-making points. This tool enhances the designer/ facilitator's ability to both guide and model students through an investigative exercise, and for learners to record their observations, reflections and conclusions. Learner contributions to the PBL task can be saved as a dynamic data file known as a FRAP form. This electronic form can be treated like a living document, to be shared between group members, and sent to the tutor at various stages during the task with questions and reflections and for comment. A component of the form can carry date-stamped comments from the tutor or student for feedback and discussion. Furthermore, this dynamic `*digital product*' may initially take the form of a template, with the embedded tutor scaffolds such as suggested actions, processes and resources, which the students can add to, delete or change.

The software was developed as a derivative of the Challenge scenario-based authoring tool (Stewart and Bartrum, 2002). However, unlike the latter, Challenge FRAP is not designed to author and display a problem-based scenario as a "game", but rather to document and understand the learners' reasoning processes and solution to a real problem, while simultaneously providing guidance and feedback as to their process. A description of authoring capabilities of the software is provided to assist the reader to better understand how it can be employed.

Description of the authoring tool

Challenge FRAP is described in detail at the site http://challenge.massey.ac.nz , where both the program and a manual can also be downloaded. The program is also now available in version 3. This version is called Challenge Workbook and is shareware rather than freeware, but version 1and 2 were used in this study, hence the screen shots show the prior versions. The differences between versions 1 and 2 are mostly cosmetic, while version 3 includes certain student requested refinements such as a spell checker. An extended version of Challenge Workbook which will allow students and tutors to share and manage FRAP (i.e. Workbook) forms via the web is also in development.

The opening screen of Challenge FRAP gives the user (student or tutor) the choices of either starting a new FRAP document, or loading an existing document. A new FRAP form simply starts up with a single activity node at the root and a blank editing page, while an existing document may be a partially completed student record or a template developed by the educator, to guide the student through the

exercise. After the user makes the appropriate selection, the program then moves to the main screen (Figure 1).

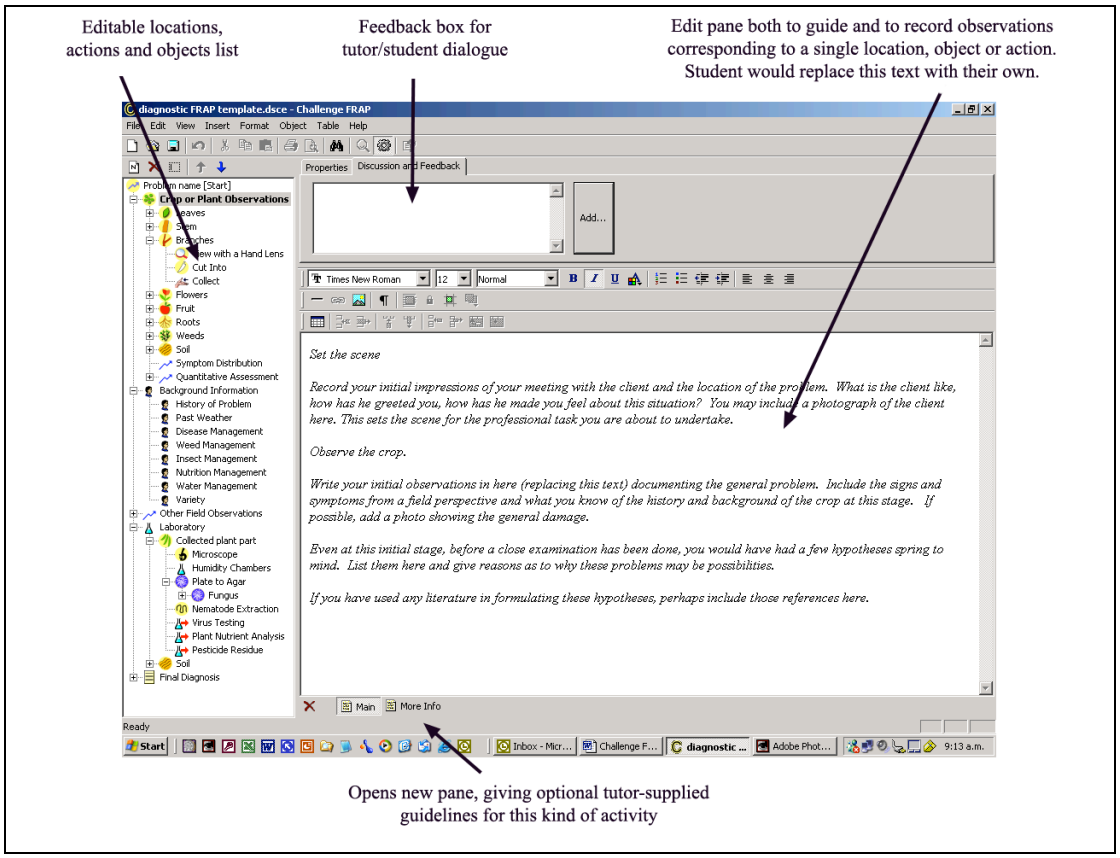

Figure 1: A FRAP template showing a plant diagnostic pathway

The authoring window is divided into three parts. The left hand side displays a series of *nodes*. These nodes can be pre-existing if a pre-designed template is being used or can be created by the students as they work through a task. Nodes can be represented by a series of in-built icons. They can represent any entity (object, location, action or theme) the student thinks is appropriate. Nodes can be organised or reorganised in hierarchies so their relationship to one another is obvious. In essence, they show a pathway of related activities that may take place (or have taken place) during the problem-solving exercise. First-level nodes can represent main activities while second and third level nodes can represent sub-activities off these main ones. In some ways the node structure could be likened to a file structure you might use to organise files on your computer.

The main right pane is an *edit screen*, and this holds the HTML content associated with each node. If a FRAP template is supplied, as shown in Figure 1, this may hold tutor-written information (suggestions, hints, directions) pertaining to the activity represented by the node. The student would replace this with their own content (showing results and reflections) once they have undertaken the task themselves. Pictures, text and hyperlinks either to the web or a local resource are all accepted.

The top left-hand screen contains a properties tab and a Discussion and Feedback tab. The latter allows input by the student and the tutor, pertaining to particular node content. All input is sequenced and date-stamped so a clear record is kept of the feedback.

FRAP files can be exchanged between teacher and student or other members of a student team for additions and comments during the course of the investigation. The enhanced version of Challenge 3 (Challenge Workbook) will allow students to collaboratively develop their FRAP files over the web.

The next section of this paper illustrates the benefits and use of this eLearning scaffolding tool through an authentic self-directed PBL project in plant pathology. This problem-solving project was developed prior to the introduction of the software, but Challenge FRAP enabled better scaffolding and reflective discourse amongst tutors and students and significantly improved the learning outcomes for students.

Case study: Teaching plant disease diagnosis with Challenge FRAP

Description of the project

A third year undergraduate course at The University of Queensland (UQ) called 'Plant Protection' used the Challenge FRAP software to support student-centred authentic problem-based learning projects. The use of the software and PBL design were evaluated by all enrolled students during 2004, 2005 and 2006 consisting of ten, eight and four third year undergraduate students, respectively. Over recent years, student enrolments in this course have diminished as a result of the national (and international) decline in student interest in Agricultural Science programs. The 2007 cohort numbered only 1 student with an additional 5 students enrolling in this course as members of a coursework Masters program. Data from the 2007 class is also included in this paper.

The students were asked to select a plant disease case from a range of authentic problems submitted for consideration by a range of horticultural industry clients from south east Queensland. Each student was provided with brief details on their selected case along with the contact details of their client so that they could consult with the client to collect relevant information and further specimens, as well as providing feedback to the client on proposed solutions . Students were aware that their work was of commercial significance to their client. They were provided with the Challenge FRAP diagnostic template and had been previously exposed to some laboratory diagnostic cases using the Virtual Plant Pathology Lab CD-ROM (Galea, 2006a; Galea, 2006b and Galea et al, 2007) developed by one of the authors at UQ (2005 and later cohorts only). The 2004 group, while not exposed to the Virtual Plant Pathology Lab CD-ROM, were provided with a special training session dealing with elements of diagnostic case management. As an initial scaffolding mechanism, the FRAP template was designed with a conventional diagnostic pathway (Figure 2) illustrated via nodes and the node contents contained suggestions and guidance on the significance of what they might observe. The elements of the pathway identified in this flowchart and their logical inter-relationship, are essential to the completion of a complete diagnostic case. Prior to assigning students with their own cases, they participated in lecturer mediated investigation of at least two "previously unknown" cases. These were solved in collaborative laboratory exercises to provide structured and supported practice in diagnostic investigation, thus modeling the approach required for their own individual assignments.

Students were given access to all laboratory and glasshouse facilities required to carry out their individual tasks and were able to consult with the client and the academic and, where necessary, receive guidance and relevant training on techniques to assist with their case. They were also given access to digital photography and photomicrography equipment as required. Although often time-consuming, this approach allowed each student to receive guidance and support specific to their own diagnostic case, further supporting the notion that clinical investigation cases are often require the development of unique (individual) solution pathways. This support often took the form of laboratory skills training (microscopy, photography, image editing, micro-organism isolation and culture) or information research and interpretation.

Students were invited to submit a draft of their template (assignment) to gain constructive feedback and further guidance from the academic. Students were able to use the discussion / feedback box available for each screen to raise questions or concerns about individual components of their diagnostic case. The availability of this tool promoted learner reflection throughout their reasoning process. Constructive feedback and counter-questioning on these and other issues could then be provided by the academic to scaffold the students towards a more polished outcome. After reflection on the feedback from the academic, and if required, further investigation of the problem, students submitted a final version of their diagnostic case FRAP file.

An example of a part of a submission is shown in Figure 3. This final submission was then assessed by the academic using a specifically designed set of assessment criteria as shown in Table 1.

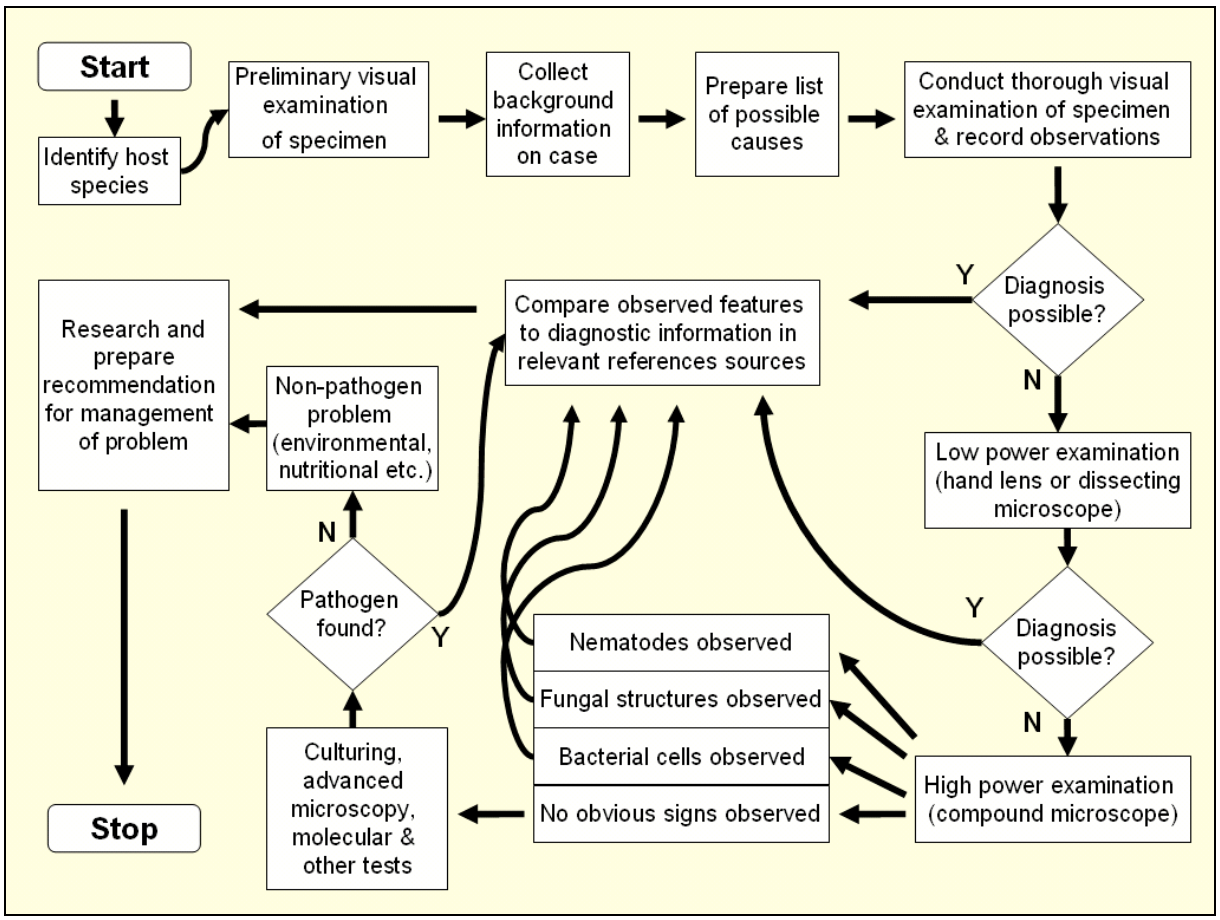

Figure 2: Flowchart describing the logical approach to the diagnosis of a plant disease problem.

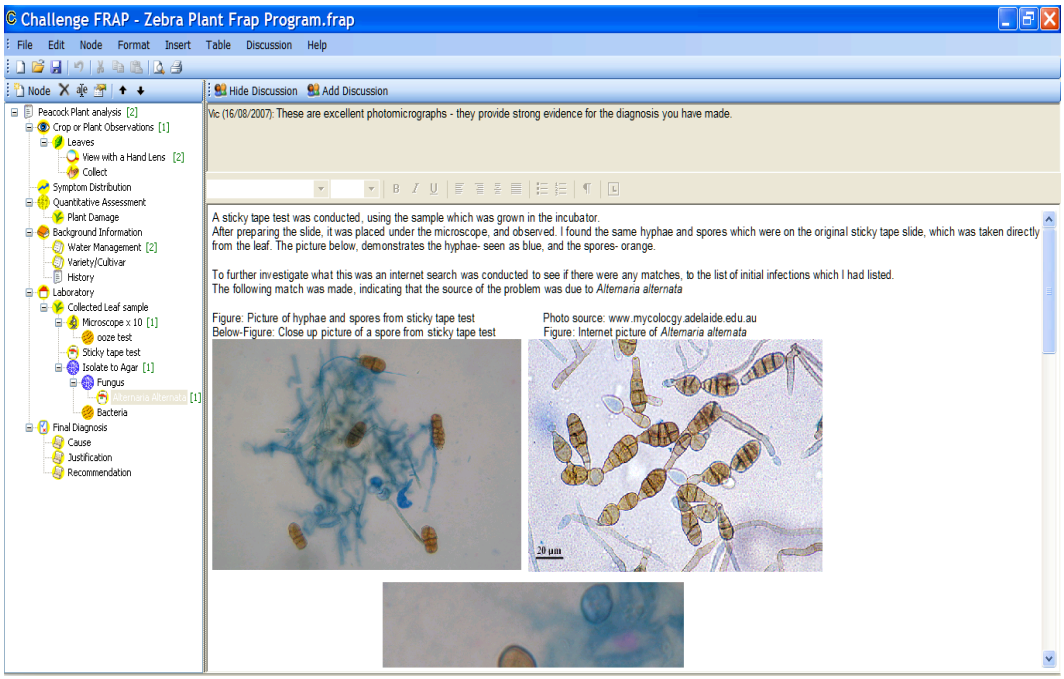

Figure 3: Screen-shot showing part of a student's FRAP diagnostic assessment

Table 1: Assessment criteria for diagnostic assignment

Criterion	Details
Introduction of problem	The plant problem and the context within which it occurs should be clearly introduced by the student.
Client consultation	Evidence of ability to consult with client should be demonstrated by the relevance and quality of information sought by the student.
Accessing information	Appropriate information sources to support this case should be accessed and evidence of this presented within the assignment
Laboratory (skills) performance	A methodical approach to the laboratory phase of this investigation should be demonstrated, along with the correct choice and use of laboratory techniques.
Diagnostic reasoning	The conclusions drawn from the diagnostic investigation should be justified and be relevant and appropriate to the information collected by the student.
Validity of recommendations	The management program must be realistic and relevant both to the production system, the crop being grown and the problem(s) to be managed.
Dedication to project	The student's dedication to the project through the quality of interaction with the client and lecturer and effort in the laboratory should be demonstrated.
Feedback to client	The student should provide evidence of feedback on the case to the client.

Student attitudes towards this particular learning approach were investigated through the use of two questionnaires. The first contained nine open-ended questions and examined student attitudes towards this exercise, its performance and resource issues. It was conducted by the students upon submission of the draft diagnostic case FRAP template.

The second, a more searching examination of value of the learning exercise, measured the success of the template as a mechanism for case development and the overall benefit of this case study approach. This questionnaire was a mixture of qualitative and open-ended questions. The opportunity for students to provide constructive feedback on the mechanisms used in this exercise was also given. The second questionnaire was completed by twenty-one of the twenty-two students upon final submission of the case template.

Results

First questionnaire
The first questionnaire was primarily designed to gain insight into student attitudes about the project and the use of Challenge FRAP in an effort to explore the way students approached their individual learning problem. The authors were particularly interested in capturing a sense of the individual journey each student underwent in their project. Student responses (Table 2) have been selected to represent the range of responses received across the nine questions asked.

Second questionnaire
The second questionnaire was completed by students upon submission of their final version of the FRAP template. Its main purpose was to more deeply assess student attitudes towards (1) the learning context of the diagnostic exercise, (2) the benefits of the FRAP template and (3) the laboratory investigation phase and to ask students to (4) reflect upon the perceived learning benefits of the project. This was done using a question bank which was rated using a modified Likert scale. A final series of open ended questions encouraged some more general reflection on the overall process (data not presented here). These questions were used to gain general feedback on some operational issues relating to the project with the view of fine tuning the project phase of the exercise and to identify areas where the Challenge FRAP template could be improved. Data from this questionnaire was examined using One-Way Chi-Square analysis. The p^a values ranged between 0.00 and 0.01 indicating highly significant agreement among the student cohort in their responses.

Questions on the learning context
Students were strongly supportive of the learning context of this exercise (Table 3) based upon the provision of a professional service to an industry client as a sole clinician. The flexible timeframe of this project and the provision of formal feedback were rated strongly by students, as was their preference for this learning model as opposed to more traditional staged laboratory exercises in plant disease diagnoses.

Table 2: Selected responses to first questionnaire and analysis - 2004, 2005, 2006 & 2007

Question	Typical student responses	Analysis
What were your thoughts about this project when you first started?	My initial thoughts were that I had never done anything like this before and it was going to be pretty hard I thought it was a new and interesting way of presenting an assignment Was a bit worried, seemed like a lot of work and didn't really know what I was doing I was interested to see what the problem was and was happy to be dealing with a plant new to me and an unknown problem Would be a great way to learn about pathogen diagnosing and also to apply concepts into the real world	Responses to this question indicated a mixture of apprehension and enthusiasm at the prospect of performing this task among students. Concerns were raised about the size of the task that lay ahead and the anticipated degree of difficulty. The novel way in which this assignment was constructed and was to be performed was also commented upon, mostly in positive terms.
What were your thoughts about this project when you reached the stage when you were ready to submit the first draft of your work?	That I had the bones of the problem presented without any padding. Probably needed more details. It took quite a bit more time and I had planned and I was not sure how much to reveal in the nodes prior to diagnostic recommendations Thought that was quite interesting, happy with the outcome and procedures to get there. Not as daunting as first thought I thought that it was very good way to present the case, something different which made it more interesting than an assignment That it required more work that it was starting to take form of a professional piece of work	While some students indicated that in reaching this stage they had invested a significant amount of time in this project, there was general sense of satisfaction at reaching a preliminary or final diagnosis for their given case. Some commented that they had found this self directed approach to learning quite satisfying and most could anticipate that further work was required to complete their assignment.
During this project, was there a particular point where your feelings towards this exercise began to change? If so, give details	When we started the lab work and the disease compendiums etc. were available, then it wasn't so daunting. Also when we got the FRAP template and it was easy-to-use in the end When I worked out what disease was on my plant I began to feel as if things were finally falling into place Halfway through the first draft I started to get very enthusiastic about the project. I could see that it was starting to all piece together Got excited when I was finding similarities to data I had collected from the Internet, after incubation of specimen No, not really. The program was easy to use and that made it easy to complete. The template was helpful in knowing what to put where	There were mixed responses to this question among students. It was clear that most could identify a clear turning point at which the assignment took a turn for the better. For some it was at the point where critical evidence pointed to a cause for the plant disease while for others it was where the diagnostic approach or the use of the software was finally mastered.
At this stage of the project, can you identify any aspects of the work you have done so far that you would have done differently?	I will probably know that when my draft is returned Possibly a bit more background research and research into diagnostic techniques No, I was happy with how I carried out the work I could have organised to meet the co-operator earlier and seen the plants in the field sooner I would have organised my work materials and information better	The responses to this question reflected the variety in approaches to the task taken by students. While some indicated that they were not satisfied with their level of initial case research (client contact or library research), a few indicated that they should have conducted a wider range of investigative tests.

Can you identify any additional resources that would have helped you progress to this stage more easily?	Soil fungi books. They are hard to find Microscope with a digital camera. More identification resources for fungi It would be nice if there was a way to identify pathogens on my own or with less assistance perhaps with a few books with pictures of the microbes. Perhaps more laboratory materials should be left out like Petri dishes etc. There was limited information on this disease relating to coriander. More research findings would have helped No, I had access to all the resources that I required	While some students indicated that access to, or knowledge of a greater range of diagnostic resources (hard copy) would have been of use to them, others pointed to better access to laboratory resources as a need.
Can you identify anything that the lecturer could have done to assist you better to reach this stage?	More availability No, but his help was absolutely vital for diagnosis A little more help would have been good but I understand that everyone has to be seen No, the one-on-one help was fantastic along with checking the first draft, great No, the lecturer was very helpful in getting me to this stage	All but two students were satisfied with the level assistance provided for this project and could not identify additional support requirements.
What do you need to do to complete this project?	Find out more about the nursery/production, hopefully get some more photos and put them in, maybe get a couple more information sources I only need to make small adjustments a little editing a few more pictures and add to references recommendations and justifications I feel I have done pretty good job and do not need to do much more to complete it make contact with John (co-operator) about the diagnosis Give client good feedback, adjust any sections on draft Do some more research about the plant, including some minor details	The variety of responses to this question reflected the different approaches taken by students. While many were in anticipation of feedback from the lecturer to complete their project, some had identified additional research of the problem with their client or through information research as a need before the task could be completed.
Can you foresee any major problems that will hinder your completion of this project?	If I have to do the recommendations again High workload at this time of the year, but really no Exact fungal identification: hard to find fungi information Time constraints with other assignments and courses either are by far my biggest concern no, hopefully it is all right	The majority of students indicated that they were confident of their ability to complete this assignment, while others listed time constraints or uncertainty about technical aspect of their findings or recommendations as a concern.

Other comments	I found the program easy-to-use, and I'm not that good around computers. Spell check would be nice on it This was a very interesting exercise, although at times it seems as though you would never find the answer - overall a good learning experience I found the assignment quite useful in giving me an idea of how to go about diagnosing the problem with a plant and how to present it e.g. in sections as in Challenge FRAP I believe that this diagnostic exercise was a valuable learning experience in a practical real-life situation. Invaluable really I found this assignment a very challenging and enjoyable experience. I would be happy to do it again	There was strong support for the assignment in terms of student acceptance of its value as a learning exercise and its relevance to their need to develop professional skills.

Table 3: Student response to questions on the learning context of the exercise (n=26)

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
I preferred having my own plant disease case to work on, rather than working through a case with other students.	13	7	4	1	1
Knowing that this was a problem of commercial significance made this project more relevant to me.	13	7	6	0	0
Having a real client to work for improved the value of this project for me.	17	6	3	0	0
I preferred working on this project in my own timeframe	9	10	4	2	1
The formal feedback received before the project was complete was useful	16	9	1	0	0
I think I would learn more from just working through a historical case, where I had to interpret given observations and lab results in order to reach a diagnosis, (along with being exposed to diagnostic procedures in lab classes), rather than undertaking this project.	1	0	2	17	6
I think I would learn more from just covering diagnostic cases in lectures and being exposed to diagnostic procedures in lab classes, rather than undertaking this project.	1	0	1	12	12
I think I would learn more from just being given diagnostic cases to read about, rather than undertaking this project.	0	0	0	8	18

Table 4: Student response to the Diagnostic FRAP template (n=26)

Question	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
The template provided a logical structure to this project	16	9	1	0	0
The template provided a useful way to record my observations and thoughts during the project	16	8	2	0	0
The structure within the template served as a model of common tasks and procedures which assisted me with my investigation	14	10	2	0	0
The template assisted me (helped me focus) when seeking information from the client	11	11	3	1	0
The comments and guidelines initially provided within the template were useful to me	13	12	1	0	0
The feedback/discussion feature was useful to me	13	12	1	0	0
The multimedia capabilities allowed me to better document the problem.	12	9	3	2	0
The fact that the template structure could be altered to reflect my own investigation was a good feature	19	7	0	0	0
The template was easy to use	15	11	0	0	0

Questions on the FRAP template
As can be seen from the responses in Table 4, the FRAP software and the Diagnostic template were viewed very favourably by students in terms of:

- the scaffolding and support it provided as they conducted their investigation
- the multimedia capability as an aid to documentation of the case, and
- the usability and flexibility of the actual Challenge software and the template.

Questions on the laboratory investigation
Response data (Table 5) showed that students were strongly engaged by the laboratory phase of the project with development of new skills and an improved level of understanding of the diagnostic procedure.

Table 5: Student response to questions on the Laboratory Investigation (n=26)

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
I was strongly engaged by the laboratory phase of the diagnosis	12	14	0	0	0
I learned new skills conducting this phase of the investigation	16	10	0	0	0
My level of understanding of the diagnostic procedure was improved as a result of this phase of the project	20	6	0	0	0

Questions on the learning benefit
This question series (Table 6) required students to reflect upon some of the broader learning benefits of the project. Again, there was strong agreement among students that the diagnostic exercise lead to development of useful skills and the integration and reinforcement of learnt theory with practice. This PBL approach successfully engaged students, thus making learning enjoyable.

Table 6: Student response to questions on the Learning Benefit of the project (n=26)

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
I have developed useful skills as a result of this project	13	13	0	0	0
I found this problem-based learning approach to be more interesting than conventional content delivery	19	7	0	0	0
The project helped improve my knowledge of plant protection generally	14	12	0	0	0
The project reinforced theory learned elsewhere in this course	12	14	0	0	0
The project served to integrate knowledge with skills	13	13	0	0	0
I enjoyed this project	17	9	0	0	0

Discussion

It was evident from the case study templates submitted by students that they succeeded in embracing the philosophy and approach to conducting diagnostic evaluations of plants with diseases which were previously unknown to them. As an eLearning tool, the FRAP template not only captured a record of their work, but also provided opportunities to embed appropriate levels of scaffolding for students to successfully complete the diagnostic procedure and to allow constructive teacher feedback at key decision-making points.

Data from the first questionnaire captured the sense of uncertainty among some students as they submitted their "works in progress" in anticipation of constructive feedback and reassurance of the approach they had followed in developing their diagnostic cases. Students were initially concerned with the size of the authentic PBL task and anticipated some difficulty. By the time they submitted their first draft, students were generally satisfied with their diagnosis and had found the self-directed aspect of the task quite fulfilling. They also reflected on their initial contact with the client and some recognised that they should have conducted more investigative testing at that stage. Students looked forward to feedback

on their initial draft and some identified that they required more research to grasp and address the problem more effectively.

It was clearly evident from the data collected in the second questionnaire, that the students had developed both a sense of confidence and competence in their ability to clinically diagnose a plant disease problem and develop recommendations for their client. They enjoyed the self-directed and flexible aspects of the task and the fact that the task was authentic and of commercial significance to the client was generally considered motivational and valuable. Feedback on their initial draft was also highly valued by students and the overall consensus was that the authenticity of the problems and the PBL design were far more influential on their learning than a traditional lecture-lab-based tutorial approach.

Students also responded well to the Challenge FRAP template. They particularly liked the structure it offered and the way it could be altered to reflect their own investigation and to record their observations and reflections. It was easy for students to use and the scaffolding modelled the common tasks they needed to complete. While the discussion and feedback feature was well received, some students were less sure about the multimedia capabilities of Challenge FRAP being useful and whether the template adequately assisted them with seeking information from the client. There was strong agreement that they were engaged by the laboratory investigation, had learned new skills and better understood the diagnostic procedure.

Students were overwhelmingly positive about the learning benefits of this approach. While students enjoyed the project, they also recognised that they their learning process had enabled them to develop more skills, improve their knowledge generally and reinforce and integrate their knowledge and theory in this area.

Implications

As this case study indicated, Challenge FRAP was used as a flexible eLearning tool for authentic PBL tasks that promoted the use scaffolding techniques, provided progressive learner feedback, promoted student reflection at key decision-making points and supported self-directed PBL learning designs. As an editing software, Challenge FRAP enabled the production of an electronic report template that could both guide the students through a problem-solving task and record their observations, progress and reflections. The tree-structure of the activity nodes were powerful in the way they could visually demonstrate how tasks related to one another and flexible in how they could be moved, changed and manipulated by the learner as they progressed their thinking. Dynamic work-in-progress files were easily passed between teacher and student, facilitating asynchronous dialogue, feedback, reflection and teamwork during the course of the investigation.

Student feedback confirmed that overall, the software was useful, easy to use and navigate, and students appeared to be impressed with the way the template assisted and recorded their engagement with the problem task. The feedback/ discussion tool, and the potential to edit the template to reflect their own investigative path were perceived as useful features of the product.

The software has the potential for use beyond what was demonstrated through this case. One student who has graduated in the plant protection area, has indicated that they plan to use the software to establish a library of problem-solving approaches to plant disease in their own professional context. It has potential application for other disciplines where student exposure to ill-structured problems, and the subsequent development of problem interpretation and solution development are seen to be of benefit. Although principally used in a clinical sciences context, the FRAP template approach to learning could also be applied to problem solving situation in other disciplines such as biological sciences, engineering, social sciences or environmental sciences to name a few possibilities.

In the initial year of operation (2004), the conduct of this project required significant additional lecturer input “outside of class time” to support student learning and case management. This additional load (estimated to be in the order of 15 hours in total) consisted mainly of one to one tuition in the laboratory environment. It has since become apparent that subsequent groups (2005 and later) who had previous exposure to the Virtual Plant Pathology Lab CD-ROM (described earlier), were more able to manage their cases effectively and mostly within the time constraints of scheduled laboratory classes.

Overall, the FRAP software, as illustrated by the case study above, enhanced authentic problem-based learning designs through the provision of scaffolding tools that assisted learners to actively engage in

investigation and inquiry and to use high level cognitive thought processes to solve real-life problems in professional contexts.

The Challenge FRAP program and example templates are available free of charge from the website http://challenge.massey.ac.nz .

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