Online student contracts to promote metacognitive development

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Knowing about one's own cognitive ability, and how best to use this ability in understanding new educational content, solving problems and making effective decisions is one of the holy grails of education! Metacognition is widely perceived as being integral to effective learning and much literature and research has been devoted to this area. However online learning environments that effectively support the development of students' metacognition are rare and difficult to develop. This paper describes one component (the student contract) of an online learning environment designed to support the development of metacognition through a cycle of planning, monitoring and evaluation. Students firstly complete a self assessment questionnaire that helps expose their preferences and orientations; this forms the basis of the student contract. The design and logic of the student contract is outlined, with an overview of the complete strategy being used to help promote metacogniton.

Keywords: metacognition, negotiated assessment, teamwork

Introduction

Adam is a multimedia student who is working for the first time on a major project with other students. The project involved the creation of a DVD video to promote a local business. "Great!" thinks Adam. He's always liked movies and enjoys design. As the project progresses, though, he starts to realise that maybe he made the wrong choice.

All the other members of his team are relying on him to do his share of the work. The problem is, when Adam started out, he promised he'd have some video ready to show the client in the first few weeks. He just didn't realise how long it would take! Now his project manager is angry at him for not submitting the work on time, the client is starting to get jittery and Adam has just been told that he also has to do the packaging for the DVD for distribution too. After all, when he signed up for the role he told the other members of the team that he enjoyed graphic design. It's now only a few weeks before the date of delivery and what seemed like a fun and trivial assignment has become a major ordeal. If this is what it's like to work in project teams how is Adam going to be able to work in industry?!

Most people have experienced the feeling of disorientation when working in new areas or tackling processes that are unfamiliar. Developing an understanding of how to learn in different situations is supported through activities such as planning how to approach the task, monitoring success or comprehension in the different phases, and then finally evaluating the success. In the example above, no planning is evident to cater for the situation, and though ongoing monitoring and evaluation are evident, this is only with the final realisation of failure.

Metacognition is often seen as something students have rather than something that can be taught. However, rather than being developmentally fixed, research is showing that the development of metacognition may be subject to instructional intervention (Boekaerts, 1997). The question then becomes one of how to promote it? Weinstein & Mayer (1986) see all metacognitive activities as partly the monitoring of comprehension, and it would appear that this ability to monitor oneself is what distinguishes metacognitive activity from domain specific cognition. Wilson (1999) defines metacognition as an "awareness individuals have of their thinking and their evaluation and regulation of their thinking".

Blakey and Spence (1990) cite Dirkes' synthesis of much of the literature on metacognition into the following features:

- connecting new information to former knowledge
- selecting thinking strategies deliberately
- planning, monitoring, and evaluating thinking processes (Dirkes, 1985).

Each of these three points defines some aspect of monitoring and control. *Connecting* new information with former knowledge is primarily driven by the context of learning, and within a framework of skills inherent in a specific task. Thus it is integral to domain-specific skills. *Selecting thinking strategies* involves the actual development of metacognitive strategies applied to a task. *Planning, monitoring, and evaluating* however, define the internal processing used to support the acquisition of domain specific skills and inform the application of regulatory strategies. These can therefore be considered key to the whole process of metacognition as they cross domains of learning and go beyond the pure application of strategies.

One of the ways of promoting metacognition is through assessment. Haefner (2004) describes an approach to assessment that engages planning, monitoring and evaluation through three different mechanisms of assessment feedback. These engage students in setting goals, evaluating their performance and monitoring their understandings through techniques that are: internal, such as self-assessment; parallel such as through peer collaboration; and external, such as tutor feedback.

This study builds on this approach by engaging these forms of feedback in a formative way, where the criteria for students judging the value of their work is negotiated over a semester. The study is based around a final year undergraduate unit in Project Management Methodology for Interactive Multimedia development. As with most final year courses (both graduate and undergraduate), teamwork is often needed to complete developmental projects that illustrate the students' technical/content skills learnt.

JAMTART – An EPSS to help promote metacognitive processing

Over the past year the researchers have been developing JAMTART, an Electronic Performance Support System (EPSS) designed to promote the development of students' metacognitive processing abilities. Design-based research has been used to inform its development, and the first module has now been designed, developed and evaluated (Luca & McMahon, 2006). Offline approaches have been used to design the modules, with student feedback gathered and analysed to help in designing the online tool (McMahon & Luca, 2005).

JAMTART uses open source software (to be made freely available), and developed with administration, tutor and student views. Educators will have the flexibility to set up assessment criteria through the use of a wizard to help contextualise the tool to any discipline. As shown in
Figure 1, the tool will contain the following modules:

1 *Self-assessment questionnaire* which provides students with feedback on their skills and attributes to help them make meaningful decisions regarding team roles and responsibilities.
2 *Team operational plan* which is based on the results of the self-assessment questionnaire, as well as students' career aspirations. The plan outlines operational guidelines the team follows as well as the negotiated performance criteria for each allocated macro task.
3 *Student Contract* which identifies the main (macro) responsibilities individual students have in the team. This ties into the unit's assessment criteria and allows students to clearly state what major roles and responsibilities they will take.
4 *Monitoring*. Each week, students enter their actual progress/performance (time, percent complete, quality and comments). This is compared to their estimated progress and performance as stated in the contract. This information is summarised and presented in graphical and tabular format to show how their roles and contributions within the team are evolving. This section concentrates on micro tasks that are related to macro tasks outlined in the student contract.
5 *Overall Evaluation & Reflection*. This portfolio tool shows summarised data such as comments, personal reflections and rationales for changes in estimations that evolved during the semester, and acts as a prompt for students to evaluate their overall performance. The emphasis here is for the students to explain *why* some tasks went off track, and why others were successful i.e. lessons learnt, skills that need enhancing and also areas of strength that can be carried forward in career options.

These map back to unit outcomes and indicate the level of achievement obtained against those outcomes (low, medium or high).

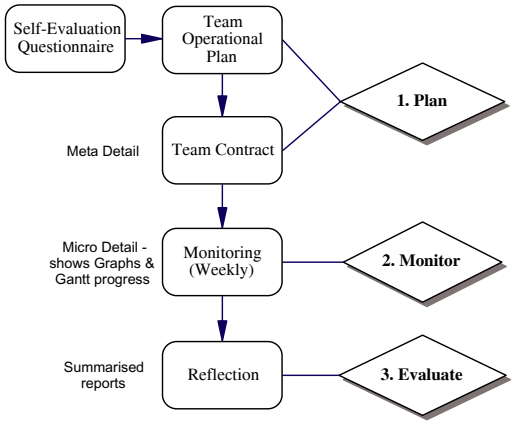

Figure 1: JAMTART – an online EPSS

Design and implementation

The main goal in developing this tool is to engage students in the processes of planning, monitoring and evaluation through peer review techniques. This was initially conducted through an offline learning approach, with a view to the construction of an online tool to facilitate the process. The basis for this approach is design-based research as advocated by the Design-Based Research Collective (2003). It acknowledges the context-laden nature of instructional settings, and the multiple variables inherent in these. Instead of controlling variables and using fixed procedures in social isolation, the aim is to characterise the situation, and allow flexible design revision and social interaction. Ultimately the researcher is a co-participant in design and analysis rather than an experimenter (Collins, 1999). This combination of both practical and theoretical components is underscored by Cobb et al. (2003) who identified five distinct features:

- a focus on developing a class of theories about the process of learning and the means that are designed to support it
- an interventionist approach, acting as a test bed for innovation
- building on the first two features, an aim of creating conditions for developing theories, but placing these theories in harm's way
- an iterative approach to design – the intended outcome being an explanatory framework that specifies expectations that become the focus of investigation during the next cycle of inquiry, and
- the theory generated must do real work – rather than developing a generic theory that may be difficult to put into practice, design experiments speak directly to the types of problems that practitioners address in the course of their work.

This focus on theory building through practical application and an iterative approach to development make this model a suitable one for a study such as this, which aims to explore metacognitive processing, but with the practical goal of developing a product that can lead to effective learning through negotiated assessment.

Context

The offline research that informed the development of JAMTART was with a group of final year students enrolled in the Interactive Multimedia course at Edith Cowan University (IMM3228 "Project Management Methods"). The unit is designed to encourage the development of a range of professional skills, as can be seen from the following learning outcomes:

1 Apply a range of project management and generic skills appropriate to the development of multimedia projects including time management, collaboration, communication, self-assessment, peer-assessment, task management, problem solving, information management and learning to learn skills.
2 Make a significant contribution to a team-based multimedia development project.

The learning environment requires students to form teams and develop web sites for clients that conform to industry requirements. Teamwork is carefully structured to allocate clear and concise responsibilities that support the development of important professional skills (Collis, 1997; Klemm & Snell, 1996; English & Yazdani, 1999). Students select their own projects, teams and tasks based on their skills and aspirations for future employment. Team based assessment is 50% of the overall mark, and included the development of a project proposal, design specification, metrics, evaluation report, post-mortem and a web site. Students are required to select:

- *Team role* – each team requires a project manager, graphic designer, programmer and instructional designer. Roles could also be shared, combined or created (e.g. media designer, content developer, evaluator and tester). These details are negotiated and finalised in the first two weeks of the semester.
- *Project topic* – selected by students to enhance their skills, though considered for suitability by tutors based on team roles, client, clearly achievable objectives value of final product.
- *Clients* – team members consider how to approach clients and establish what commitment and input they would give the project. The client is requested to pass comment on the quality of the final product.

A custom built online courseware management system (http://www.scam.ecu.edu.au/) is used to deliver the content in blended mode, and a final product is compiled on the university server (see http://studentprojects.scam.ecu.edu.au) as an on-line CV to help students promote themselves to potential employers. The web site contains the project name, description, team members, their roles, web site URL, and documentation (project proposal, design specifications, metrics, evaluation and post-mortem).

The learning environment promotes an authentic context that provides tangible benefits for the students. Not only do students end up with a CV item they can show potential employers, but also the design of the unit provides an opportunity for students to identify their strengths/interests and nurture them in a supportive environment.

Negotiated assessment

This unit has been designed over a number of years through gradual refinement of teaching and learning approaches based on design based research. The focus was to design a learning environment that integrated teamwork with negotiated assessment to help students and tutors make informed decisions about transferring marks between team members to promote equitable teamwork, as well as helping students understand the value of their own and others contributions.

The educational design focus is on learning activities that are authentic, self-regulated and reflective (Luca & Oliver, 2003). Project work is integral to the unit and students liaise with real clients to scope, design, develop, evaluate, cost, schedule and track projects, reporting on discrepancies and developing documentation that has direct relevance in the industry. The final product and documentation is hosted on a university server for students to use as an electronic CV to enhance employment opportunities. This authentic context provides motivational value in which students are encouraged to take ownership for their own learning by selecting their project topic, team members and desired team roles to match their aspirations for employment.

Students complete a *Self-Assessment Questionnaire* designed to help them gain understanding of their team skills i.e. administrator, analyst, negotiator, verbal communicator, written communicator, listener, motivator or decision-maker. This helps determine their skill deficiencies and strengths when working in a team. Once this is complete, they then develop a *Team Operational Plan*, where they outline the operating rules of the team, including individual goals, team goals, meeting strategies, task assignment issues and communication, a decision-making process and conflict resolution strategies. The final stage in the process is the *Student Contract*, which outlines the main (macro) responsibilities individual students

have in the team. This is tied into the unit's assessment criteria and allows students to clearly state major roles and responsibilities (Table 1).

Students use the team contract to negotiate their assessment items and continually review these for each assignment, by reflecting on how successful they and peers have been in completing the tasks outlined in the contract. Each row in the Team Contract represents a key assessment point and students can consider the extent of their contribution based on their aims for future employment and current skill sets. With four students in each team, each student's contribution should constitute 25% of the overall mark. However, this is not mandatory, and students can specify how much of the "assessment pie" they want. This negotiation of assessment is conducted in two stages. Students consider:

- Estimated Contributions – at the beginning of the semester students commit to completing a series of tasks by specifying their tasks
- Actual Contributions – when each of the team assignments are submitted, the Team Contract is re-submitted. Students then complete their "Actual Contributions", with a review of the mark they actually contributed. The team and tutor all agree to the reviewed mark, and this information is used to re-distribute marks to help promote fair and equitable teamwork.

Table 1: Team contract

Assessment Items	**%**	**Name 1**				**Name 2 etc..**			
		EM	EQ	AM	AQ	EM	EQ	AM	AQ
Online Tasks	16								
Project Proposal	10								
Design Specifications	5								
PM Doc 1	2								
Application Development	5								
Presentation & Online CV	2								
Evaluation Report	3								
Metrics Report	3								
Post Mortem	2								
PM Doc 2	2								
Total	50								
Signatures									

Note. EM = Estimated Mark, EQ = Estimated Quality, AM = Actual Mark, AQ = Actual Quality.

It is anticipated that having students negotiate each assessment item promotes responsibility within the team, as well as define the quality expected from each team member. So when the actual assignments are submitted, it is clear how much effort/quality each team member has contributed. Also, the fact that the assignment components are authentic, and aligned with good practice, helps motivate students contribute to this process.

Beyond the issues of fairness and equity, this negotiation also involves students in planning their learning, by setting goals and estimating their performance both in terms of outcome (mark) and process (quality of work). They are required to evaluate these goals against actual achievement when the assignment is submitted. Through this cyclical process and through the internal, parallel and external feedback mechanisms of peer, tutor, and self-assessment, students are engaged in a continuous process of self-monitoring.

The implementation of the team contract is based on planning, monitoring and evaluation (Dirkes, 1985). By week three students plan and negotiate assessment items they are responsible as well as predict the quality of these. As the semester progresses, students continually monitor their own performance in terms of their stated plans as well as their team members' commitments. If they felt the team is not progressing as agreed, they have team meeting or inform the tutor. As well as ongoing modification of their initial plans, students formally evaluate their performance and that of their peers when the assessment item is submitted.

It is on this basis that the design of the student contract was formulated for the online tool (JAMTART).

Design of an on-line component to support reflective practice in the negotiation of student contracts

The student contract module of JAMTART reflects the process that has previously been conducted offline and builds on the existing self assessment module where the feedback provided through self assessment can be used to select roles in multimedia product development and monitor their performance in those roles during the development lifecycle. Unlike the self assessment module, administration of the student contract module is conducted primarily by students themselves. The three components that are integral to the module are:

- set up contract
- monitor contract
- project overview.

Such components adhere to the metacognitive focus on planning, monitoring and evaluation, although as can be seen through the following design, self-monitoring underpins the majority of learner activity as they engage in monitoring their performance throughout the duration of the project.

Setting up the contract

This component of the student contract module is the one that has the most input from the teacher. The teacher's role in setting up the contract is to:

- set up projects for students to subscribe to
- define a target level of performance for the project in terms of overall hours
- define the monitoring period for each stage of the project, i.e. the frequency that students are required to evaluate their performance and modify their commitment to various jobs within the project
- set global parameters for the monitoring component such as whether students have the option of making their comments public or private
- sign off on each student's commitment to the project.

For the teacher, this sets some important foundations for the project. For example, the decision to provide the option for private or public comments has important implications for the value of the environment to promote metacognition. The management of the project requires openness and accountability between students and this is an argument for public comments. However, should there be issues within a team then the validity of these comments could be compromised by making them public, in which case the option to make comments private is a useful one, and can provide a useful supplement to the private self-evaluations in the Evaluation module of JAMTART.

Having the teacher set a nominal overall number of hours provides a basis for students to commit to jobs. It ensures that students are thinking strategically in terms of allocating their time and provides a basis for assessment. The percentage of hours that they distribute between jobs can be used to provide assessment weightings for those jobs.

This is best shown from the students' perspective when they come to assign themselves to jobs. The Set up contract component enables students to:

- Define a role for themselves within the team. This is informed by the initial Self-Assessment Module of JAMTART and will be different for each individual depending on the nature of the project and the number of team members.
- Define jobs that are relevant to their role, and proportion hours for each job based upon the nominal hours allocated by the teacher.
- Assign themselves to other existing jobs where those jobs are to be shared.

These parameters then carry over to the monitoring component.

Monitoring the contract

Figure 2 demonstrates the interface of the main monitoring component of the student contract module in storyboard form. As can be seen, the module adopts a structure similar to a GANNT chart where students and teachers can get a summarised visual overview of the jobs, their duration and the students assigned to them. From this screen students can add a job to their role, delete a job, or select an existing job to contribute to it. They can also see the jobs other members of the team have allocated for themselves and the extent to which these jobs have been completed.

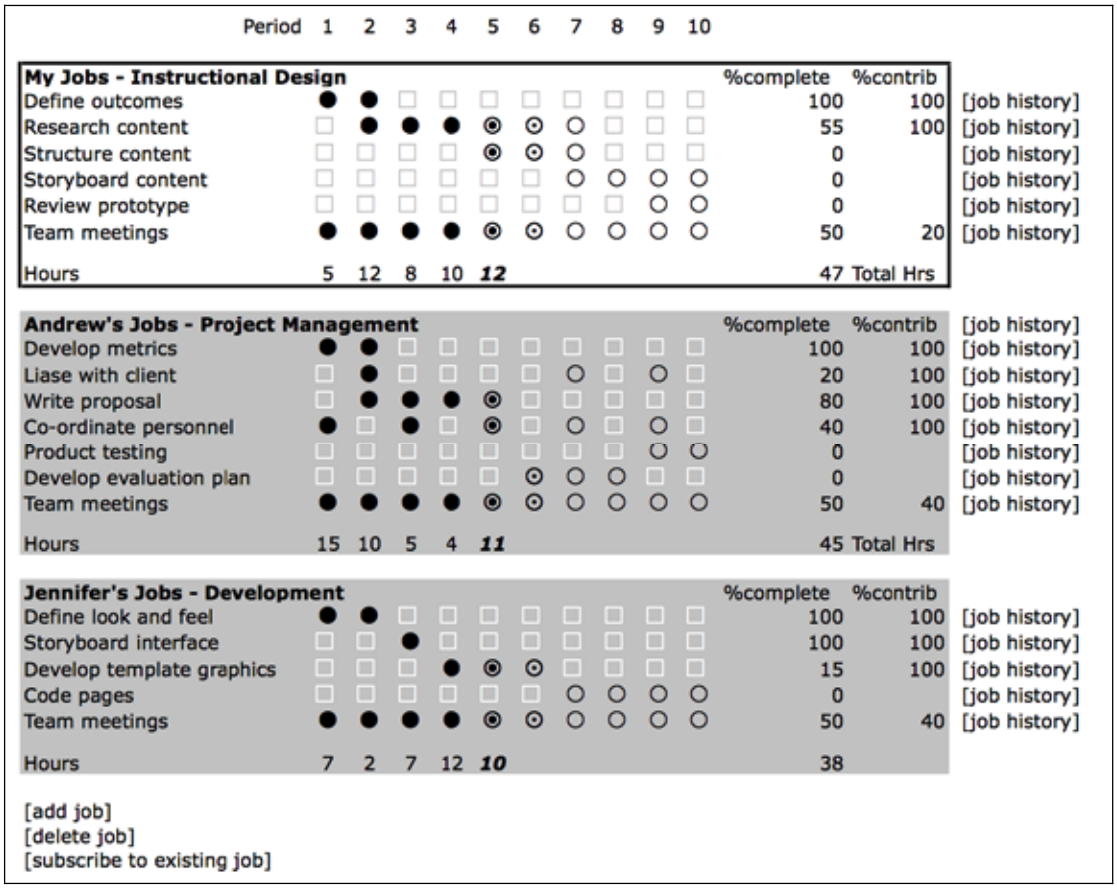

Figure 2: Student contract view

For each period, the status of the job is shown. These are:

- Inactive, represented as a ☐
- Active for a previous period: ●
- Under review for the current period: ◉
- Estimated for the next period: ⊙
- Allocated for future period: ○

Clicking on one of the above icons brings up a 'Job Card' for that period (Figure 3).

In the Job Card view, a student is able to provide estimated hours that will be spent on the job as well as the actual hours and estimated percent complete. Feedback will also be provided in the form of the amount of hours that have been spent on a job to date, the previous estimated percent completion and the percent contribution that that student has made to the job. These statistics provide a finer level of granularity than is available purely from the contract view.

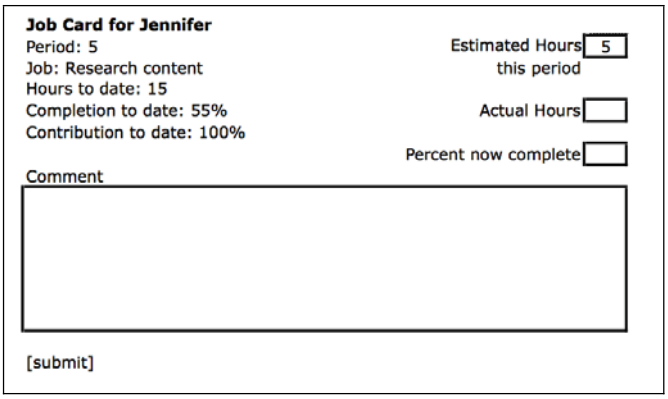

Figure 3: Job card view for a specific job and period

Most importantly, there is also room for comments. In this section, the student is required to comment on the work that was completed during that period, giving reasons for why a job took longer or shorter than was expected or issues that cropped up that prevented the student from allocating the amount of hours to the job that was initially estimated. It is these comments that form the basis of students self-monitoring. The self-evaluation, and reconfiguration of plans forms the processing inherent in students developing metacognitive approaches to their work and provides an audit trail for negotiated assessment.

All of the information contained in the job cards contributes to the summative information provided within the student contract (Figure 2). The hours underneath each period provide an overall aggregation of the hours the student has spent on the project. For individual jobs, clicking on 'job history' presents the hours spent on an individual job during the duration of the project as well as the comments and specific period data from the job card. The job history also has the advantage of including data provided by all the students who have contributed to a job. In many cases it is expected that other students will take over some of the responsibility for a job when one team member is too busy to do it all. At the same time, there are jobs which are shared by several members of the team. An example of this is team meetings. All members participate and the time spent on these activities needs to be identified and accommodated within the system (it also traps for issues such as team members who do not attend the meetings!). The percentage contribution presented in the Student Contract view provides a summary of this aspect of job completion.

Project overview

The final component of the student contract module is a project overview. This provides a view of the data for the student contract in a form that can help team decision processes during the project development. The information contained within the project overview is highly summarised and organised around the project itself rather than students' individual roles. The aim is to display the overall status of the project and to provide a means for the project manager in conjunction with the rest of the team to reallocated jobs within roles and report back to their tutors and clients. This is particularly useful when jobs are shared within a team and an overview is required of the job itself rather than individual member contributions. This global information, while less relevant to individual decision processes, provides some of the facility of a project management tool, eliminating the need for data to be duplicated between JAMTART and applications such as MS Project. It also supports the social negotiation of jobs within the team and could form an initial basis from which students then review and adjust their contract in the Monitor Contract component.

Implications and future developments

The proposal within this paper describes the basis of design-based research into a tool to allow students to monitor their performance within project teams. The goal is to support students' metacognitive development through the processes of planning, monitoring, and evaluating their thinking. This forms the main component of a broader suite of tools that will begin with self-assessment and lead to the final self-

evaluation through the reflection on a final portfolio that provides an audit trail for all activity within the project.

As design-based research, the student monitoring module of JAMTART will provide a refined instantiation of a model for negotiated assessment that has worked in an offline manner successfully for students learning project management. It is expected that the tool will be implemented in 2007 and subject to further research.

Most lecturers have met an 'Adam' in their class, and arguably most practitioners can still remember feeling the same disorientation that Adam felt when having to contend with new scenarios that not only require them to apply learned skills but use their understanding of themselves and the task to develop new strategies. Adam will not be made 'metacognitive' within one semester, but by engaging him in the subordinate processes of planning, monitoring and evaluating his performance, the awareness developed through his use of JAMTART will better equip him when faced with new problems and scenarios which require him to use his understanding of himself and his own thinking processes to develop his own strategies for success.

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