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Addendum A Category creation table

Focus group 2

Category	Codes	Quote to support creation of category	Comment
Facilitation Lecturer-student interaction	Face to face facilitation	"I think you should also consider having it facilitated face to face. Rather than working off a printed sheet. Because what happens then, is if you do step by step and they've gotta follow you step by step as soon as there's an issue they you can actually go and address a specific question that they've got." "You might give this to them as a reference for later on. Bit the first time they encounter that you actually facilitate a simple example but on a face to face basis." "… a group of logistics students might struggle to grasp the concept of programming logic, but I think just to support them, give a handout but also maybe go through it step by step in class as well. To pre-empt any problems that they might have." "If you gonna use paper, you gonna end up with quite a hefty manual if you have to predefine everything and give the examples. Even if you explain to them what a variable is, its still not gonna make sense until they see an example."	The initial handouts may have been confusing / to advanced and difficult to follow. There were too many gaps that needed to be filled in through face to face facilitation. Examples needed to be worked through in class, facilitated by the lecturer on a face to face basis. The step by step guide could serve more as a reference then an initial exposure to the expert system shell. Face to face facilitation would be particularly important for students who have not had exposure to programming. There are too many unforeseen issues / problems / occurrences that the students may encounter to anticipate them all in a paper-based tutorial. Face to face facilitation allows you to address these on the fly.

	Step by step guide	"I think just to support them, give a handout but also maybe go through it step by step in class as well. To pre-empt any problems that they might have." "If you regard that this will be the tool to design the expert system in the end. It shouldn't be an obstacle. They should have a handout for reference later on. You explain and then in their own time they can come back and look it up again." " Might help when … you know if they do forget then they've got an assignment and they've got to go and refresh and … what the students do is, they sit in class and they nod seemingly intelligently and understanding, but they don't really, so if you can give them something that they can kinda play with later on."	The sense here is that the step by step guide should serve as a reference for later and should be supported by face to face demonstrations of examples. If they are going to learn to use the software then they will need an understanding of the steps involved to be able to use it appropriately.
	Demonstration	"I would start from the simple and progress. So the demonstration that you do has got to be really the simplest kind of problem that you can give them that will incorporate all the software elements."	This might be the same as 'face to face'. Demonstrations were done using data-projectors. Simplest example that demonstrates all the elements that they are likely to use when they create their own expert systems.

Handouts Composition of handouts	Step by step guide	"I think you should also consider having it facilitated face to face. Rather than working off a printed sheet." “Generally the handout is a good idea, I think. Step by step guide to take them through this" "I think just to support them, give a handout but also maybe go through it step by step in class as well. To pre-empt any problems that they might have." "They should have a handout for reference later on. You explain and then in their own time they can come back and look it up again." "Might help when … you know if they do forget then they've got an assignment and they've got to go and refresh …"	Handout must support other activities like being a refresher for face to face interaction and when undertaking practical exercises. Handout must be composed of a step by step guide that serves to using the software to create an expert system.

	Handout	"... the variety of problems that you will encounter will be quite vast, so to try and cater for everything on a handout is kind of difficult." "… if you gonna use paper, you gonna end up with quite a hefty manual if you have to predefine everything and give the examples." "You might give them this to them as a reference for later on." "A group of logistics students might struggle to grasp the concept of programming logic, bit I think just to support them, give a handout" "…if you test their language proficiency it's not really that good. And then to give them a handout with proper English written on it might not be that useful to them." "I also think there's also the terminology used in the handout, might be an obstacle. You'd need to explain that some" "I also think there's also the terminology used in the handout, might be an obstacle. You'd need to explain that some." "And really simple language and you're going to have to predefine terms all the way."	It would be Impractical to incorporate or anticipate every problem that the student may encounter using a handout. This is one of the reasons why it must only support things like face to face facilitation. The handout might be particularly useful for students who have not had much exposure to a software development environment. Handouts must be written using language and examples that the students can easily understand. It must not be taken for granted that the students will understand all terminology; these need to be explained in the handout. (Predefining terms all the way might clutter the handout and make it too bulky). Handout for reference purposes.

	Handout (continued)	"They should have a handout for reference later on. You explain and then in their own time they can come back and look it up again." “So a bit later, when they've gotta go and figure stuff out, they're not completely lost."	
Scaffolding Providing scaffolding Building in scaffolding	Face to face facilitation	"I think you should also consider having it facilitated face to face. Rather than working off a printed sheet. Because what happens then, is if you do step by step and they've gotta follow you step by step as soon as there's an issue they you can actually go and address a specific question that they've got." "You might give them this to them as a reference for later on. But the first time they encounter that you actually facilitate a simple example but on a face to face basis." “… a group of logistics students might struggle to grasp the concept of programming logic, but I think just to support them, give a handout but also maybe go through it step by step in class as well. To pre-empt any problems that they might have."	Initially there will be too many issues that will be unfamiliar to the students and anticipating these in a handout will be difficult to do. Face to face facilitation will allow the students to have their particular concerns / problems / lack of understanding addressed as it arises. The face to face facilitation is particularly important for students who have not had any exposure to a programming environment.

	Handout	"The variety of problems that you will encounter will be quite vast, so to try and cater for everything on a handout is kind of difficult." "… if you gonna use paper, you gonna end up with quite a hefty manual if you have to predefine everything and give the examples." "You might give them this to them as a reference for later on." "A group of logistics students might struggle to grasp the concept of programming logic, bit I think just to support them, give a handout" "… if you test their language proficiency it's not really that good. And then to give them a handout with proper English written on it might not be that useful to them." "I also think there's also the terminology used in the handout, might be an obstacle. You'd need to explain that some," "I also think there's also the terminology used in the handout might be an obstacle. You'd need to explain that some." "And really simple language and you're going to have to predefine terms all the way." "They should have a handout for reference later on. You explain and then in their own time they can come back and look it up again."	

	Examples	"Even if you explain to them what a variable is, its still not gonna make sense until they see an example." "If you want to use a variable, you gonna have to tell them in simple English what a variable is. With an example."	
	Start simply	"I would start from the simple and progress. So the demonstration that you do has got to be really the simplest kind of problem that you can give them that will incorporate all the software elements. So just to show them what everything means." "… start with a simple problem and then perhaps progress to a bit more complex problem. And the more complex the problem becomes, the more you gonna start kinda focusing on the problem and not as much on the software." "I don't think you should start with a complex ill-defined problem, rather just something simple just so that they can see how the software works and then go from there."	Use simple problem just to illustrate how the software is used. At this point the problem must not get in the way of learning to use the software. As the problems become progressively more complex the focus will shift from learning to use the software to solving the problem
Cognitive challenge	New way of learning	"It is a new way of learning to them. It's not something they're used to."	Because they are not used to this way of learning they might find it more difficult than usual but at the same time the novelty might make them enjoy the challenge more. They may approach it with more diligence.

	Developing something for themselves.	"… they will enjoy developing something for themselves, instead of being given something, as per usual, in the classroom." "… the time when you really start learning the software is when you do something that is meaningful." "But this initial tutorial, I think you'll have to go and follow that up with giving them an actual project to go and do at home or something so they can figure stuff out."	Once again, enjoy because of the novelty but also because of the stimulating process of being hands on. (Applying understanding to something). 'Meaningful' takes the learning from the abstract to something practical, tangible and meaningful. This will enhance the learning. Supplement the tutorial with a practical exercise. The tutorial alone will not suffice; they will not gain a full / meaningful understanding if the tutorial is not supplemented by something practical.

	IT Students Hard for non-IT students	" IT students, that's probably gonna be a good selection, given that they need to work with a little bit of programming logic, because they might be a little bit more familiar with the programming logic than the kind of general student." "Not the IT students as much, but the broader population is going to have difficulty with that." "I think you gonna battle if you work with logistics students, for example." "… a group of logistics students might struggle to grasp the concept of programming logic, bit I think just to support them, give a handout but also maybe go through it step by step in class as well. To pre-empt any problems that they might have."	Leaning the software seemed to be a steep learning curve at this point. Provide the students with a significant cognitive challenge if they had not been exposed to some sort of programming environment before.
	Time		
	Terminology	“I also think there's also the terminology used in the handout, might be an obstacle. You'd need to explain that some." “And really simple language and you're going to have to predefine terms all the way. So if you want to use variable, you gonna have to tell them in simple English what a variable is."	

	Learning to use the software	" .. not a difficult problem because then they're gonna start focusing on the problem. And they gonna get themselves lost in the problem and not focus on the software kinda thing." “I don't think you should start with a complex ill-defined problem, rather just something simple just so that they can see how the software works and then go from there."	

Focus group 3

Category	Codes	Quote to support creation of category	Comment
Scaffolding Providing scaffolding Properties: •	Battle on your own	"… battling a bit on your own is a good one from a certain stage on. I think that if you just go and dive in and you start to figure it out, that might just become a bit demoralising. "So, to a limited extent, let them try stuff on their own for a while. For a brief while. Not too long. And then show them the right way. So that they not only learn what you teach them in class, but also that little bit extra that they discover."	Allowing or encouraging students to battle on their own is only constructive / beneficial from a certain stage in the learning process. It would be counterproductive to compel them to work completely on their own to soon in the learning process. (could relate this to the 'Build on basic knowledge' code). Students should not be left to struggle on their own for too long before the facilitator intervenes and provides them with guidance. This will allow them not only to learn from the guidance provided by the facilitator but from the process of self-discovery.

	Break into bits	"What I think you could do to get around the speed issue, is to do something, and then stop and make them do it. Not to just let them watch through the whole presentation and then the first thing they're gonna forget again." "I really think the screen freeze is very good to use. Once you've done a step just to freeze the screen and then give a little written explanation of what you've just done."	'Speed', maybe 'pacing' or learning content more efficiently. Breaking material into small chunks allows the student to assimilate material more effectively. A long, uninterrupted presentation may result in excessive cognitive load. Presenting material using a 'screen freeze' method may be an effective way of breaking it into manageable chunks.
	Decrease in the scaffolding	"You did kind of decrease in the scaffolding quite good today kind of thing. In the same way the first one, step by step, do or show something and let them do it. Then the second one you kind of step back a little bit and you ask them, okay, what must we do next and then they must do it. Then you say, okay, do this now on your own."	Decreased scaffolding: 1) Step by step demonstration. 2) Ask class to tell what comes next. 3) Do it on their own
	Direct interaction	"What I found very useful when you demonstrated is that I had the opportunity to directly ask you a question, immediately, when I didn't understand what was going on. Whilst if I did it on my own, I would maybe have forgotten, but the direct interaction is good." "The show and tell, and then the 'do'. If that works together and you are there to assist and give direct feedback."	Students could ask questions as soon as they encounter difficulties. This 'direct interaction' allowed them to pose their question to the facilitator before they had forgotten the problem that was encountered. (Interactional support)

	Examples (Worked examples)	"You made us work through examples which showed us which question would work and what would not work. For the result we wanted in the end …" "… if you go and you do basic example and then you give them something that they have to try and figure out on their own, and you give them a while to play with that."	The reduction of extraneous cognitive load through the use of worked examples.
	First put things on paper	"What worked for me is to first put things on paper. Like generally works for me in any event. You write things out and see how it works out there and then from there on you show us the tutorial." "If they can do it here on paper, then it should be easier for them to transfer it when they see what they are doing and then they can do it themselves on the computer." "… you've broken it down into logical bits which follow on each other. First the paper-based, then working on your own, then you demonstrating and I could apply what I learnt and I could see the logic behind what you were doing there because I knew what the symbols stood for."	Plot the logic of the expert system in an algorithmic flow-diagram. Could this have something to do with cognitive load? (I.e. battling with learning the software interferes with the grasping of the logic of the expert system design). Plotting it on paper reduces the cognitive load because once you are familiar with the flow-diagram symbols; you can concentrate on the logic of the expert system and not on how to use the development software.
	Screen capture	"Screen print that you demonstrated will be very useful. Where you break down into a capture of the logical steps." "… as you went through it now, it was a bit quick and if you did it in that way, it would've been easier to follow." “I really think the screen freeze is very good to use. Once you’ve done a step just to freeze	A screen capture of the steps involved in developing an expert system based on a 'worked example'. The demonstration 'freezes' at logical (salient) points during the development, students can interact with the demonstration and 'start' it again once they feel they are ready.

		the screen and then give a little written explanation of what you've just done."	
	Sequence	"First the paper-based then working on your own, then you demonstrating and I could apply what I learnt and I could see the logic behind what you were doing there because I knew what the symbols stood for. You made us work through examples which showed us with question would work and what would not work." "… battling a bit on your own is a good one from a certain stage on. I think that if you just go and dive in and you start to figure it out, that might just become a bit demoralising." "… first put things on paper. Like generally works for me in any event. You write things out and see how it works out there and then from there on you show us the tutorial. If it makes sense then, I think after that then the students must do it themselves."	1) paper-based. 2) Facilitator demonstrated. 3) Apply learning (could now understand logic behind what was being done). Can't allow students to battle on their own too soon. Must be done at a certain stage in the learning process. Start simply or in a way that is more familiar, more comfortable. First principles: (a) activation of prior experience,(b) demonstration of skills (c) application of skills and (d) integration of these skills into real-world activities.
	Pace (Slow pace)	"… your pace must be slow. Especially if you go through the functions and make sure that they all see it and also that a guideline needs to be there; it needs to be double-checked on this."	Pace must be appropriate to the complexity of what is being demonstrated and the ability of the students. Supported by a step by step handout that can be referred back to.
	Start simple	"I think after that then the students must do it themselves, but I think the main thing is to start with a simple one like here in the beginning when it's only two options so that they can work it out."	This is directly related to intrinsic cognitive load. Intrinsically the concepts involves are too complex to be accommodated in working memory

		"I think for the first class, just do the basics first, and one question, and a simple algorithm and then build on that further." "First get the basics under control and then carry on with the more involved things."	all at once; simple versions have to be presented to the students so that schemata are created in long-term memory. These schemata are then brought back into working memory when the complexity of the concept needs to be understood. Flow-diagram with only one or two options in order to reduce complexity.
	Step-by -step	"In the same way the first one, step by step, do or show something and let them do it. Then the second one you kind of step back a little bit and you ask them, okay, what must we do next and then they must do it. Then you say, okay, do this now on your own." "But you can like probably break this down into about 3 or 6 stop- starts, where you do something and you say, okay now it's your turn. You go and build it." "So if they can, after each step just do it and then they should be fine."	Again this seems to be related to intrinsic cognitive load. After each step (logical step) the students consolidate their understanding by applying something; this may assist in the creation of schemata in the long-term memory.
Discovery learning Properties: • Active learning • Meaningful learning	Build on basic knowledge	"… as your foundational knowledge increases, it's easier for you to relate new stuff to it. So if you play around without having any foundational knowledge there's nothing to make linkages to. But as you build on the foundational knowledge, it becomes easier to make new linkages to it."	In discovery learning students are encouraged to undertake activities that build on existing or foundational knowledge (Castronova, 2002:2)
	Trial and error	"But I also think that trial and error is very important because last time I sat and I got stuck at a certain point and once you have gone through the whole process slowly, it	Discovery learning does not place significant importance on correct answers and considers failure as a constructive part of the learning

		makes sense now, but just to find the correct pitch between trial and error and doing it by themselves and giving them the information that will be tricky, I think. To find the correct balance between doing it on their own and providing them with information."	process (Castronova, 2002:2). Discovery learning incorporated within guided learning strategies where the facilitator establishes some sort of balance between letting the students find their own way and guiding them toward a desired outcome.
	Apply learning	"First the paper base, then working on your own, then you demonstrating and I could apply what I learnt and I could see the logic behind what you were doing there because I knew what the symbols stood for. You made us work through examples which showed us which question would work and what would not work."	Emphasis on active participation or construction of understanding.
	Battling on your own	"… battling a bit on your own is a good one from a certain stage on. I think that if you just go and dive in and you start to figure it out, that might just become a bit demoralising." "… what happens in the process of fiddling is you then discover other things which don't answer your question now but stays in the back of your mind for later on when you've got the question that needs this answer. So, to a limited extent, let them try stuff on their own for a while. For a brief while. Not too long. And then show them the right way. So that they not only learn what you teach them in class, but also that little bit extra that they discover."	Guided discovery learning. Facilitator must provide appropriate guidance during the discovery learning process.
	Sequence	"… first put things on paper. Like generally works for me in any event. You write things out and see how it works out there and then from there on you show us the tutorial. If it makes sense then, I think after that then the students	Explore the structure of a discovery learning environment.

		must do it themselves." "… battling a bit on your own is a good one from a certain stage on. I think that if you just go and dive in and you start to figure it out, that might just become a bit demoralising." " I think after that then the students must do it themselves, but I think the main thing is to start with a simple one like here in the beginning when it's only two options so that they can work it out." “I think for the first class, just do the basics first, and one question, and a simple algorithm and then build on that further."	
	Hands on	“What I think you could do to get around the speed issue, is to do something, and then stop and make them do it. Not to just let them watch through the whole presentation and then the first think they're gonna forget again." "But you can like probably break this down into about 3 or 6 stop-starts, where you do something and you say, okay now it’s your turn. You go and build it." "I think if you provide them with too much information, then and without them doing it on their own, they will also feel lost." " … if you go and you do basic example and then you give them something that they have to try and figure out on their own, and you give them a while to play with that.". “… the better they get at using the software,	Active participation is a property of a discovery learning environment.

		the better they get at discovering stuff by play around." "So if they can, after each step just do it and then they should be fine."	

Focus group 4

Category	Codes	Quote to support creation of category	Comment
Domain appreciation Subject awareness	Brainstorming Explore students' understanding (this could be a category)	"… maybe have a brainstorming session about different communication contexts in little groups, umm, but just to create the context of what to expect in the class and then getting feedback from all the groups I think that then you already have something to work with …" "… instead of just explaining everything ask them what their understanding is of the concepts before you start. And then break it up."	Brainstorming or exploring the classes or various groups within the class's current understanding of various communications concepts may provide the facilitator with an insight into the general level of understanding within the class (base level understanding) Give the facilitator an insight into where to pitch lessons and not to make unrealistic (baseless) assumptions. Brainstorming sessions may also create awareness within the students of various communication contexts and concepts.
	Clarify domain concepts	"We spoke earlier about your need to explain what the different components actually mean if you talk about *context* what do you mean, if you talk about *audience* what do you mean by *audience,* so perhaps just remember when you get to the section of the questionnaire that deals with context that you just step back a little bit and explain exactly what you mean by context and when you get to audience just	Paper-based exercises should be supported by other activities that explain and clarify various domain specific concepts. It should not be assumed that students have a foundational understanding of the subject.

	Avoid making assumptions	explain a little bit further." "Terminology like the word *context*, like the word *situations*, things like that. The assumption is maybe that they would know what it means, but I don't think we can make that assumption."	
	Example	"…give them an example maybe of the communication situation if you want to, I know you said that you didn't, but make it something different then the context that you have there, like a corporate environment, make it something different that they can't use. That will give them an idea of along which lines they should think." "You can give them scenarios as example; you don't have to say this is exactly how I want it but it gives them a cleared direction of what is expected from them, umm, I mean it helps to give them more guidelines, I mean you don't have to give them the recipe, they have to figure out the recipe for themselves here."	Providing examples may be an effective way of making the Communications concepts less abstract. The concern, however, is that the example may simply be regurgitated when students are left to explore the concepts on their own. It may inhibit (interfere with) the discovery learning process. The examples need to be designed in such away that this situation is averted. The examples / scenarios should serve as guidelines without directing the students too definitely. Not giving them the 'recipe'? Could the examples be in the form of problems without exact solutions, almost like ill structured examples?
	Must know where to start	"I know you want them to struggle but they should have an idea of where to start otherwise they might not know what to do." "They know what you want to achieve; instead of you tell them what you want them to achieve at the end they have to bring in their input, they have to trust in their creativity that they are going to create something that hasn't been	When exploring or embarking on a discovery learning process, students will be disorientated if they are not giving sufficient guidance. The need to be given some sort of direction to start from. Similar to building on foundational knowledge.

		before. You know something like that. For me it's a bit more guiding, and then when you come to this part where they have to develop the flow-diagram the moment that they get their beginning must be clear otherwise they will not be able to do this."	The starting point must be apparent to the students otherwise they will feel disorientated. Examples, scenarios should form part of this orientation process.
	Face to face	"I think that the questions could just be more specific and if you have a forum where you have face to face interaction with the students while they work that terminology should be explained and that feedback should be given after each logical gap."	Immediate feedback from the facilitator could provide the support necessary when students work through paper-based exercises.
	Handouts	"I think the fact that you gave us paper-based questions so that we had something in front of us to work with was a good idea."	The paper-based exercises served to facilitate group discussion and an exploration of various communication concepts and situations.

Focus group 5

Category	Codes	Quote to support creation of category	Comment
Representing a conceptual understanding	Bridge the gap	"Well the way that you demonstrated it here facilitating, sort of another brainstorming session but not doing a mind map, doing the flowchart immediately. That would bridge the gap for me back again to the flowchart and show me what would be the end product, that you would expect from me, without telling me what to do and what to put in specifically. " And then if you guide that discussion towards, let's say product as a concept, you start talking about you know what's on the board there what … you know discuss about, without telling people that they are discussing product, you just start leading some kind of	Lesson outline (this was done during the following lesson): **Step 1** Brainstorm with class to explore understanding of Communications concepts. **Step 2** Divide class into groups, send all but one group out of the class and show that group a video clip of a communication situation. **Step 3** Invite the other groups back into the class and ask them to determine what the context was in the video clip by posing questions to the group that remained in the class. Record

		discussion on what the product is. And once they have discussed that a little bit and explored and got them to what you really want them to understand about product then you can step back and summarize for them." “That is a good way of them kind of analysing the situation first and then reducing all that discussion down into a formation of a concept."	these questions using a white board or data projector. **Step 4** Repeat with other groups **Step 5** Consolidate the questions through class discussion. **Step 6** Demonstrate to the class how these questions and answers can be represented using a flow-diagram and IF THEN statements. The flow from creating or gaining an awareness of various Communications concepts, to formulating questions to probe or explore these concepts with reference to authentic examples and then to represent these insights immediately using a flow-diagram could create a seamless transition from conceptual understanding to a representation of this conceptual understanding. The relationship between an understanding rooted in a specific instance and a more abstract representation of this understanding is made evident by immediately transferring the group’s reasoning onto a flow-diagram. There was a seamless progression from analysing an authentic example to representing a conceptual understanding that resulted from this analysis to a flow-diagram that could then form the basis of a functioning expert system. Without this immediacy

			the students may find it difficult to bridge the gap between a conceptual understanding and a representation of this understanding. By allowing an unscripted class discussion to developed or be transformed into a flow-diagram that can then be converted into a functioning expert system may encourage students to consider the process to be an authentic or accurate reflection of their understanding. They may, consequently, be encouraged to recognise this representation as a true expression of their socially constructed experience.
	Contiguity	"… if you could do a video clip and have them discuss a concept, like purpose for example, and then once you have summarised and told them this is what purpose is about and then move directly onto flowcharting purpose, then it keeps everything together and it actually gives them a good understanding of what it is when you talk about a flowchart what it is that you are trying to achieve from them. So I think what you did there was quite a good way of doing that."	The contiguity of the discussion of the concept and the representation of the concept using a flow-diagram enables the student to understand the logic behind using a flow-diagram to represent their understanding. It creates a more concrete or obvious link between the concept and its representation.
	Flow-diagram	"Do this and then go on to do maybe one example of their own, there own scenario. Exactly like last week but maybe one scenario. Because then they will know what it's all about and then move on to their own flow-diagram. That can work the two exercises together."	Once they have understood or appreciated the link between a conceptual understanding and a representation of this understanding they can proceed to represent a scenario informed or

		"It worked well for me, the flowchart immediately." "I think that it links nicely, theory with practice, the flowchart. Because now they did the theory, all these concepts and now they must just represent it practically in an expert system, and, umm, I think this provides a good link between the theory and the practice."	inspired by their own experience using a flow-diagram. This could be the other way round. The practice could be seen to be represented in the video clips and the theory could be seen to be represented by the flow-diagram. Perhaps the flow-diagram could be considered to be a concrete or hands-on representation of a theoretical understanding?
	Representing understanding (alternative)	"… depending on the need of the student or maybe his way of expression that they can either do the flowchart or then write it out in natural language which … it could be a preference … you can give them the opportunity to choose between the two, ummm, and there might be somebody that is most comfortable with doing the flowchart and then writing it out so before he gets to the expert system then he knows that there is nothing in-between that I left out." "For the purpose of them understanding of the concept it might not be the best way for them to understanding the concept. So that's why I say the flowchart might obscure their understanding but then again I've got my lecturer hat on and thinking about what's going to make the students understand best."	Representing conceptual understanding using a flow-diagram should not present the students with an unnecessary learning curve. They may feel more comfortable using natural language to represent this understanding. Some students may not find representing their understanding in this way to be helpful. These students may prefer to use 'natural language' to do so.
Facilitating a conceptual understanding of the domain	Domain knowledge	"… What we missed last time was the step in-between and this lesson was the step in-between. From the beginning when you explained the expert systems and then the CMAPP … so it was very good and. giving	The exercises were not as open-ended but contained multiple-choice questions related to a video clip that they were shown. This seemed to facilitate a better

		some … something more sound that's not completely abstract so I think it's a good idea." "… you can use different video clips to do that, you; can use one video clip for product and one video clip for purpose for example So you take the next video clip an you start discussing the purpose without telling them that that's what you are doing and you take a step back and you summarise and you say OK, in that video clip this was the purpose so that they understand these things that they had running around in their minds now, that that goes to purpose." "That's a good way of them kind of analysing the situation first and then reducing all that discussion down into a formation of a concept."	understanding of the domain and related an understanding of the domain to the expert system concept and logic. Using different video clips, the facilitator can focus on different communications concepts. Each video clip must highlight or enable a discussion on a discrete communications concept. These concepts must emerge naturally, which may involve the facilitator selecting video clips with the different learning points in mind (Bearing in mind the different learning points when selecting a video clip). This would facilitate and analysis of various communications situations and then the formation of concepts.
	Example Scenario	" I like that you take context and you work through an example in detail, like we did today and you go back to the video clips and we start discussing some stuff in the video lips." "… modelling their own diagram based on their own scenario, like last weeks exercise perhaps. It would work well after you have done that example. And they are still not going to model what you have done there; they will still have to think about it themselves." "… maybe we should swop the two exercises from last week and this week. Do this and then	The discussion of the various communications concepts is rooted or grounded in a realistic situation or a practical demonstration. This realistic situation can be referenced in order to allow learning points to emerge or conceptual understanding to take place. Once they have developed a model of their understanding of various communications principles that emerged as a result of

		go on to do maybe one example of their own, their own scenario. Exactly like last week but maybe one scenario. Because then they will know what it's all about and then move on to their own flow-diagram. That can work, the two exercises together."	watching video clips, the students may be ready to formulate their own scenarios and develop models related to these. (This was tried in the week previous and considered to be to difficult and disorientating)
	Handouts Scaffolding	"I also like the paper-based exercise because scaffolding was provided by first starting with multiple choice, just opinions and then later they had to express themselves in writing and then in paragraph form as well. So I think that it was well structured and scaffolded and also visually"	Initially the handouts were considered to be too complex because of their open-ended nature. Scaffolding in the paper-based exercises by giving the students multiple-choice options from which they could choose and answer. It was only subsequent exercises that were more open ended in nature (Choose options that related to the video clip). Progress from guided options (multiple-choice) to open ended, where they even formulate their own scenarios.
	Video clips	"The segmented way that we did this and the video clips the visual really I think will draw in the students and the real-life situations, the complex real-life situations would help them a lot." " I like that you take context and you work through an example in detail, like we did today and you go back to the video clips and we start discussing some stuff in the video lips." "… you can use different video clips to do that, you can use one video clip for product and one video clip for purpose for example So you take the next video clip an you start discussing the	The video clips may help to situate the learning in a real world context and make the students appreciate the relevance of the learning. Give them an insight into the complex nature of communication in a real life situation. The video clips serve as a useful reference that may reinforce a conceptual understanding (Ground the learning). Video clips can be selected specifically to highlight certain

		purpose without telling them that that's what you are doing and you take a step back and you summarise and you say ok in that video clip this was the purpose so that they understand these things that they had running around in their minds now, that that goes to purpose." "…the students will have real visual interaction with the videos that you are going to show and based on the videos they can answer these questions." "… The visual clips were very interesting, that's always interesting to students to have something like that and not everything paper-based. So I think that will be a good starting point or point of departure for the students." "… when you do the t paper-based exercise, to do a clip and then make them answer the questions on it, do a clip and make them answer the questions on it. Because it keeps the content of the video fresh in their minds as well while they are busy do that."	communications concepts. Might allow for a discrete separation of the various communication concepts. Perhaps some of the clips may have certain of the concepts as more prominent but the others are still there (the other concepts can be pointed out in the clip once an overall conceptual understanding has been gained).
Guiding / directing domain analysis (Scaffolding)	Class discussion	"And then if you guide that discussion towards, let's say product as a concept, you start talking about you know what's on the board there what ... you know discuss about, without telling people that they are discussing product, you just start leading some kind of discussion on what the product is. And once they have discussed that a little bit and explored and got them to what you really want them to understand about product then you can step back and summarise for them."	The face to face discussions concerning the domain must be allowed to develop spontaneously. The learning points should emerge naturally and then made more apparent to the learners during a consolidation and summarising phase.

	Face-to face	"I think the face to face interaction worked very well. I think the way that we progressed with facilitation through the concepts worked very well." "I wouldn't go and give them more paper work, I would go … do the basic concepts that you did multiple choice questions etc and then do the rest segmented, umm, with all the other concepts face to face based on the video clips again."	The integrating of face to face facilitation, paper-based exercises and the viewing of video clips depicting realistic situations must be carefully managed. The paper-based exercises can be used to introduce basic concepts to the students. This may make the viewing of the video clips more meaningful to the students and lead to more constructive class discussions. The face-to face facilitation allows concepts to emerge spontaneously during class discussion.
	Feedback	"This worked well because there was a lot of feedback and discussion.	Obtaining feedback from the class is important if concepts are to emerge spontaneously.
	Real-life situations	"The segmented way that we did this and the video clips the visual really I think will draw in the students and the real-life situations, the complex real-life situations would help them a lot."	The real-life situations depicted in the video clips would help make the concepts less abstract for the students.
	Segments	"The segmented way that we did this and the video clips the visual really I think will draw in the students and the real life situations, the complex real life situations would help them a lot." "I wouldn't go and give them more paper work, I would go … do the basic concepts that you did multiple choice questions etc. and then do the rest segmented, umm, with all the other concepts face to face based on the video clips again."	Breaking a complex situation into sections to facilitate analysis. Use the paper-based exercises to supplement the face to face interaction. The learning environment must be structured around face to face interaction at this stage. Going through the learning concepts in stages, referring back

		"I like that you take context and you work through an example in detail, like we did today and you go back to the video clips and we start discussing some stuff in the video lips." "… when you do the this paper-based exercise, to do a clip and then make them answer the questions on it, do a clip and make them answer the questions on it. Because it keeps the content of the video fresh in their minds as well while they are busy do that."	to the video clips to underline and reinforce learning. Referring back to the video clips to initiate discussion once the students have gained some insight into the concepts. It is advisable that there to be close contiguity between the viewing of the video clips and the discussion that aims to facilitate the emergence of learning points.

Focus group 6

Category	Codes	Quote to support creation of category	Comment
Scaffold thought process / scaffolding flowchart construction	Bridge the gap	“I think you bridged the gap very well today, jumping from the conceptual learning to physical manifestation in the flowchart. For me today there wasn't that moment of hesitation of what should I do next, it flowed naturally and that worked well.” “The idea behind today was to bridge the gap between a conceptual understanding and a representation of that understanding. How do I improve this?” “It was natural for me … when you had the questions … remember they have seen all of this … asking the questions and they know what those shapes mean now so now when you put the question there then obviously they have to think of all the different settings for example and then take one and what's	The lesson facilitated the seamless progression from a conceptual understanding to an articulation or representation of this understanding in the form of a flow-diagram. The development or formulation of the questions helped to make the construction of the flow-diagram seem natural. The formulation of the questions developed naturally from the class discussion / activity. This separation of question formulation and flow-diagram construction may relieve the intrinsic cognitive load associated with putting together a flow-

		involved there, that is logical to me." "…here were things that you had to think about but because you already had those questions it just made that gap more digestible and easier to work with." "…in one of the previous sessions, where we had to make that jump, I had to readjust my mind and ok now we are going to the flowchart, what now. What question is first? What should happen now? And with the questions already developed today, you could basically just apply it to the flowchart and there were not so many things that you had to consider so that it wasn't as daunting a task."	diagram that represents the student's conceptual understanding of various communications concepts. Intrinsic cognitive load is reduced by allowing for the development of the questions before the drafting of the flow-diagram. The logic of the questions is applied to the drafting of the flow-diagram.
	Flow-diagram	"… nice I think way of getting to the logical way of flowcharting something like context … It was a nifty idea to do it this way round, I think it might work well." "… What you are doing is you are going through the thought process that they need to follow to get to the questions that they need to ask to get to the flowchart without them knowing that that's what they are busy doing." "I think you bridged the gap very well today, jumping from the conceptual learning to physical manifestation in the flowchart. For me today there wasn't that moment of hesitation of what should I do next, it flowed naturally and that worked well." "…why did it work well? "Umm I think it was a natural progression into	Guiding students through the thought process that needs to be followed to draft a flow-diagram that articulates the logic of an expert system. Formulate questions that can be asked to explore various communications concepts embedded realistic communications situations. Using these questions to construct an algorithmic flow-diagram. The subtle guidance will allow the students to see the process as less contrived and artificial. This may help them appreciate the relevance and serve as a source of motivation. The subtle natural guidance prevents students from wondering what the learning agenda might

		… because you have already now drafted the questions and you don't have to now go sit and think, if I do this flowchart now what would be the best question to ask, what would … to develop questions, because now the questions are there already." "Because that, umm, will tell them that the order of the questions … now this is difficult because as you said sometimes some questions do lead on to the other, umm, but unless that is like really really apparent from the questions that you would need to ask this question first. If there are five questions and they are all equally important, it doesn't realty matter where you start, I would ask them where do you want to start from so that they understand that they can start from any place and the way in which they do it is not going to be incorrect if you start doing it at a different place." "… that thing about, that there are many different ways of representing that because your learners … especially if they are like younger learners they are going to want to copy what you are doing. So if you don't make that very clear you are gong to see all of your flowcharts looking like this and you ... I don't have to tell you that." "… here is really where the learning is going to start taking place, when we send them back in their groups to go and develop a flowchart on their own."	be. Natural progression from general class discussion to a realisation of the logic of an algorithmic flow-diagram. The natural progression may serve to prevent excessive cognitive load. It is advisable for the facilitator to adopt a flexible approach. Must be guided by the response or feedback obtained from the class. Try and accept the students are responsible for guiding the learning outcome and the formulation of the questions, etc.

	Group work Practical application	"I think that it is important to, from here on, to take that … to give it to groups to do some work on their own, to really get to grips with what this process is."	Class discussion and then guided facilitation of flow-diagram development must be followed by a practical application of understanding.
	Logical	"It's logical also because we have that background and you have done that in the beginning, showing how this chart works, that was good. If you haven't done that and you get this, now then I would have been lost …"	Preceding steps make the process logical, an understanding of flow-diagram symbols, expert system logic.
	Real life	"I think using the newspapers, using the clips, the real-life environment; I think that worked very well. It's not something separated from what they do everyday, they see that this is real life, this is how it is and they can work through this. It's not a separate concept that they have to grasp."	Situating the learning within authentic or realistic settings may make the learning more relevant to the students. The learning is situated within settings that the students are better able to relate to.
Facilitator responsiveness / awareness	Constructivist facilitation	"Your facilitators need to be trained for constructivist interaction. That's not something that comes natural." "… first thing that he needed to do was to actually train the facilitators how to facilitate a constructivist learning environment. That's not something that they learn naturally." "Naturally you want to stand here and you want to lecture down to people. So you need to get used to this constructivist environment where the learning belongs to you constructors, not to your facilitator. And when you have a dead spot you need to trust that dead spot, you need to know that that's part of the process you know and how to facilitate through that perhaps. But ,umm, if these guys aren't trained and they walk in there and they encounter a dead spot the natural reaction is	It is advisable to allow the learning points to emerge naturally from the class discussions. The questions that are formulated must emerge from the class discussion. No question must be added to the list that has not emerged naturally from the class discussion. The facilitator must not impose a question on the class, all questions must emerge naturally. Facilitators must be sensitive to the fact that the learners must direct the learning outcomes. The class activities must be facilitated in such a way that the learners feel comfortable to freely make contributions. They must be guided not to expect to be

		to start lecturing, umm, so they need to be trained on how to facilitate in that kind of environment." "… you ask them the first question and nobody answers you and you wait for a while and there is this unnatural pause and then you start talking and there you have lost the plot. That's something that they need to learn how to do and once that happens … that's just the first. Now you've got a group of learners who've never really worked in that way, so they need to become familiar with a constructivist learning environment, they need to overcome their natural resistance to speaking up in a group and to participate because you cant construct knowledge, especially in a social constructivist paradigm, you cant derive group meaning if nobody is speaking. So you need to do some training beforehand before this is going to work."	provided with answers or solutions by the facilitator. The facilitator must probe for contributions and resist a natural tendency to fall back on conventional lecturing techniques. It is advisable for the students to recognise the questions and flow-diagrams to be an authentic representation of their understanding or cognitive conceptualisation.
	Facilitation	"I also agree with them about the facilitators and maybe your first class or the first thing, when they introduce it you should maybe there just to check that they know what is going on and they are doing what they are supposed to do. Otherwise you are going to, umm, leave it all in their hands and then in the end maybe get some feedback or information that this is not quite what you were hoping for." "… because that's where they are going to start negotiating amongst themselves to get a flowchart on the ground. So I think that's really where the understanding is going to start, when they start interacting with each other and in that process I think the first couple of times,	Importance of correct or suitable facilitation. Facilitators must be in tune (sensitive to) with the feedback elicited from students. Must be prepared to make adjustments and amendments to learning environment and interaction. Responsive to feedback obtained from the class. The students' understanding is going to develop from the discussions that surround the formulation of the flow-diagram.

		you as facilitator, are actually going to learn much about how t facilitate this kind of thing." "… so then you will be able to tell them, this thing that you are doing here just think about it this way. So your facilitation is also going to be responsive to what they come up with." "The facilitators in class will have to be very invested in this and you will have to train them." "Because once you get the first representations back you are going to start understanding how you students understand stuff. So that will tell you what they are doing right and what, in inverted commas, what they are dong wrong, in inverted commas."	The facilitator should be sensitive to this evolving understanding and make adjustments in response to this. Facilitators need to be responsive to the feedback obtained from students. The facilitator needs to adapt guidance in response to the feedback received from the student group. The unconventional or unfamiliar nature of facilitation in this type of learning environment requires a greater level of commitment from facilitators.

Focus group 7a

Category	Codes	Quote to support creation of category	Comment
Facilitating the development of the expert system Scaffold the class development of an expert system Converting the flow-diagram into a functional expert system	Class exercise Learn by doing	"Once we have got a flow-diagram representing their group's understanding of context, I want to do exactly what we did now. In other words, let's develop the expert system as a class and invite volunteers from the class to come and do it while the audience shouts instruction, support, guidance to those persons." "I found that when I was looking I kind of had an idea but as soon as you sit and do something yourself then you get the proper idea."	The previous class required the group to formulate questions in order to explore a particular communications concept or concepts imbedded within video clips. An algorithmic flow-diagram was then drafted, using the questions and answers prepared in the step above. This flow-diagram was then used as the basis for the development of a functioning expert system using CourseLab as an expert system shell. Students were first prompted to make a contribution to this development

Scaffolding the conversion of the flow-diagram into a functional expert system		"I think that it was necessary because we hadn't done it for a while and then we didn't really know what we were doing. So in today's groups it was necessary." "… it's going to refresh their memories pretty soon if they have forgotten some stuff. So I think if their prior knowledge is adequate then at this stage you won't have to work individually again like we did today."	through probing questions from the facilitator and then invited to sit at the workstation on which the development was taking place and, with guidance from the class, continue the development. The progression from formulating questions to drafting a flow-diagram to developing a flow-diagram was designed to articulate the link between a conceptual understanding and the development of a functioning expert system. Looking at the development taking place gives you an idea of what's going on but the real understanding or a confirmation of understanding only really takes place when you attempt it yourself. It may be advisable to work through the development as a class in order to refresh the students' understanding of how to use the expert system shell. This is particularly important for those who have not had much exposure to a similar development environment.
	Demonstration	"…facilitator can control the screen of the students. So you can physically take control of the screen and show them what you see on their screens." "… will the students also be able to see what you do on the computer on their own	A data projector was used for this demonstration / class development. Taking over or controlling what appears on the monitor at each student's workstation would allow students to see the development taking

		computers or will there be one overhead, cause that's not going to be practical, in those huge labs.”	place clearly and would also allow them to try certain aspects of the development easily on their own. This would be particularly useful for larger groups where students are likely to disengage if they are not able to follow the development process easily.
	Means of assessing logic	“… the nice thing about building an expert system like that is that it is quite easy to assess, I don't know whether that is the right word, to assess whether their logic is valid. Because if you look at the screen when you do the screen preview kind of thing, they have got two conditions selected and they have got a display and if those things match up logically it means everything else must be in place.” “It doesn't matter how they got to the answer; you just interested that they get to a valid answer. So what you can do is to go around and have a look at everybody's, you know, thingy, what they selected and what the display is and you know whether they have done it right or not.” “A jig and you take something and you put it in a jig and if it fits then it works.” “You don't necessarily know what the representation is but you know it’s valid because it comes up with the "right answer.”	The development of the expert system facilitates a close examination of the logic of the algorithmic flow-diagrams that were formulated during the design phase. It also allows for an examination of the validity of this logic.
	Group work	“… are they going work in pairs in small groups physically in the labs, that's something we should think about, cause it worked well now when we worked in a group together.”	The first development exercise can be done as one large group (class) but it is advisable to follow this up with a similar exercise where the development takes place in

		"… the first one everybody does together with the lecturer so they see it on the screen like we did now, the second time you can make groups."	smaller groups where each individual student will have an opportunity to participate.
	Learn from one another	"… what I liked about this is the approach that we worked together as a group and that we kind of reminded each other and that we learnt from each other. So it was kind of a socio-constructivist approach here."	The class collaboration allows for a mutually constructed understanding and peer support. Individuals within the class have different levels of experience and understanding, collaborating allows for individuals to support one another.
	Feedback	"… remember when we learnt the software, if they had mastered it then, today might not have been that necessary and you will be able to pick this up when you start doing this and the students can immediately tell you what to do next then you will know that they are on the same page" "Unfortunately the only time that you are going to know whether they know enough is when you start doing this. Because if you start doing this and you don't get answers or you get the wrong kind of answers then you will know that they don't have the prior knowledge that you assume."	The response from the student group will give the facilitator insight into their level of understanding. The facilitator would need to be sensitive to this awareness and facilitate the development process accordingly. The facilitation needs to be appropriate to the needs of the students. The lecturer would need to be responsive to the feedback obtained from the student group and adjust the level of support appropriately.

Focus group 7 b

Category	Codes	Quote to support creation of category	Comment
Problem composition and formulation	Scenario	"How do we present the ill structured problem to the students? Gerhard: I think by giving them a scenario because that will be … the problem will be situated within a real-life scenario and it will	Problem must be situated within a realistic situation or set of circumstances.

		give the a little bit of information or structure." "So I think scenario, they must be presented with a scenario."	
	Composition of the scenario	"… you have to think about the communication in that scenario" "I think that when you describe your scenario you must have five components kind of covered in the scenario and the ill definedness of the scenario depends on how much information you give to them when you describe the scenario." "The problem is ill defined if they need more information they can go back to the video as many times as they want and get more information from that and then ultimately they can develop their expert system based on their understanding of what happened at that meeting. And I'm saying a meeting, you can use something else, it's just the first thing that came to mind." "The outcome should be implied in the ill structured problem? Gerrit: The information and stuff should be given in there, its just that you have got to make sure that they pick it up, they might not pick up that …"	The scenario in which the ill defined problem is embedded must be designed to allow for the learning outcomes to emerge. The open ended or ill defined nature of the scenario might allow for broad understanding of Communications concepts. The solution to the problem is not implicit in the scenario; so learning outcomes are not dictated or restricted.
	Ill-defined	"I think that when you describe your scenario you must have five components kind of covered in the scenario and the ill definedness of the scenario depends on how much information you give to them when you describe the scenario."	The solution to the problem (dilemma) must not be obvious or prescriptive. This may not elicit a representation of the students' understanding and will lead to duplication or regurgitation.

		"…you can describe that scenario in the greatest of detail and everybody will come up with the same kind of answer. But if you leave some information out … the more information you leave out the more ill defined your problem becomes." "The outcome should be implied in the ill structured problem? Gerri: The information and stuff should be given in there, its just that you have got to make sure that they pick it up, they might not pick up that …"	The ill defined problem must allow for the emergence of the desired communications concepts. Must accommodate the emergence of these concepts. 'Implied' within broad parameters. Without being prescriptive or overly directive the facilitator must ensure that the students detect the communications concepts embedded in the ill structured problem.
Providing support (scaffolding) for problem comprehension	Authentic evaluation	"My feeling about that is that it is just about as authentic as you can get it if you want to go the way of having an expert system developed to let somebody who doesn't know the expert system use the expert system because that's what expert systems are for, to get people who weren't involved in the development of the expert system." "…its more authentic then using you own expert system because you can read stuff into your own expert system but somebody else doesn't know the assumptions that you built into your expert system so that way round if they use the expert system and they use the display stuff to come up with the product."	Evaluating the expert system by asking other groups to use it to solve a communications problem. This would make the task more authentic and test the validity of the expert system logic effectively.
	Assessment	"I think that there needs to be a rubric that comes from the beginning through till the end certain sections, they are either competent or incompetent."	A rubric may be too prescriptive. Guidance needs to be given in terms of what an expert system is. The application developed must be an expert system that is comprised of the various components of an

		"I think it is important ahead of time to give them an assessment rubric, to tell them what it is that you are looking for and if you make the group self-assess or peer assess … as long as they assess in terms of you initial rubric." "…you get the group to critique the expert system and then they get the opportunity to go back and fix whatever didn't work well. But this takes time; that is my big concern with what we are doing here is that it all takes time."	expert system. All progress evaluation should be evaluated in terms of the students understanding of the expert system concept. Their applications must not be an aggregate of the various options selected but must rather be 'reasoned' response to a problem outlined by a novice user. Students must clearly understand what an expert system is and that effective progress in their development is dependent on this understanding.
	Facilitation	"I think that it should also be put in writing, the problem statement should be put in writing and as a support you show a video. Maybe … I think … it mustn't be taught or lectured, it must be in the background, and the lecturer must be in the background." "I think that's the right word is to scaffold the learning so if they ask you a question you ask them a question back, so you don't want to give them direct answers to questions kind of thing but you want to guide them in the right direction." "… you don't want to be directive but you want to elicit thought so if they ask you a question you don't tell go and do it like this, you tell them about different things that they should consider for themselves, so it's a provider of scaffolding not a …" "… he would be like a resource, so if they would get stuck they would ask him questions	The facilitator must perform a supporting role. The facilitator must provide the learners with guidance by questioning their thinking. Or posing questions that stimulate thinking and provide guidance. Must not provide the students with direct answers to questions but must provide guidance concerning along which lines they should be thinking. The facilitator must not be too meddling and intrusive; he must respond to the students' enquiries rather than impose his advice on them. The facilitator must ensure that the design and development explore appropriate communications concepts. The facilitator must carry out sufficient monitoring to ensure

		but he doesn't hover around them and check that they are doing it correctly; so they go to him if there is something that they are not quite sure about, kind of supporting them if they need him." "…when you facilitate you have to make sure that they have got something in their model that says *context*, they can use another word for it, that's fine but they must have something that says *context* and they must have something that says *product* and they must have something that says *audience* or what ever the case may be" "…if don't make sure that that happens, they can come up with a model that is kind of an incomplete model and in our environment we have a responsibility to actually convey, umm, a proper model." "… they get all the information from the ill structured problem that they need to get from it, so you need to guide them in that direction." "… if you see there are some shortcoming you do your, *what about this what about this* question; move them in the right direction."	that the students are exploring and representing appropriate communications concepts. The facilitator must ensure that the students grasp the rationale behind the ill structured problem.
Group collaboration / interaction	Compare and contrast understanding	"… we used to do home groups and specialised groups, so you get … you get two sets of groups. So for every specialist group you give one component to go and explore and then you reconstitute. So they work in different groups on the components and then they come into the home groups and they share their understanding and in that way you do have that where …"	Allowing different groups to work separately on the same task and then at the end of each development or planning session the various groups would get together to discuss their individual development. This would facilitate the comparison and contrasting of ideas and understanding. Take the

		"What if after a period of development I combine groups and they take the best of each and they come up with one? What do you all think of that concept?" "… like at conferences and work sessions when you do like breakaway groups and people come back and they do report backs." "… if you have your different groups go and construct models, come back and report back to the bigger group, but then importantly they have to go back to their groups and redefine their understanding." "… perhaps an easier way of doing it rather than a home group specialist group thing because the numbers in the class will affect how the groups work."	best of all the development activities to reinforce conceptual understanding. Facilitate the exchange of ideas.
	Home group	"… we used to do home groups and specialised groups, so you get … you get two sets of groups. So for every specialist group you give one component to go and explore and then you reconstitute. So they work in different groups on the components and then they come into the home groups and they share their understanding and in that way you do have that where…" "… perhaps and easier way of doing it rather than a home group specialist group thing because the numbers in the class will effect how the groups work."	Formulation of the idea of various groups getting together to compare and contrast design and development ideas.
	Interaction	"I think that more leaning takes place when interactivity takes place and discussion takes place."	Socio-constructed understanding, etc.

Focus group 8

Category	Codes	Quote to support creation of category	Comment
Construction / composition of the problem statement	A brief	"… a brief is much more, umm, open in terms of not limiting the students to a specific scenario and its much less prescriptive and the fact that it is on paper so that you can go back to and refer to it again."	Instead of describing a particular situation, give the students a brief that outlines a concept. The problem is not situated within an artificial scenario but rather in the form of a conceptual brief that could be applicable to a variety of situations.
	Contains background information	"…"its long, but I think that it has all the background and the information and it's not obvious what they should do. They will have to think and that's why Eunice and I sat for a while and decided what it is that we will have to do."	The brief provides background information to the concept that needs to be explored. It sets the scene without hinting at an obvious solution.
	Not straight forward	"… it is not straightforward. Your have to go through that and decide … you have to in the group decide what the actual problem here is. You have to see what the problem is before you can carry on and develop this."	The problem statement was in the form of a brief that outlined a concept. It was not in the form of a clear-cut scenario where a solution is implied by the situation itself. It was open-ended and could accommodate a variety of approaches. An obvious problem is not imbedded in the problem statement. The problem statement presents the students with a broad outline of a situation that is reasonably intangible. The problems are more of a conceptual nature and are not rooted in the particulars of a situation.
Engaging with the problem statement	Constructivist	"… if handout the homework assignment ahead of class that means you are directing what happens during class because they know	If the facilitator hands out or makes the students become aware of the problem statement too soon; this

		that they will have to find answers to these questions. What will happen then is that they will use the interactions to answer those questions which is not the constructivist way. If you handout the instructions at the end of the class, they don't have the resource of group discussion ahead of them to get the answers, so what they will have to do, they will have to consult their mental model of what occurred during the course of the event to answer the question so probably that is the more constructivist way of doing it." "… the open problem that you gave them fits nicely into your constructivist approach. Because it's open-ended and it's ill defined so I think it's a very well constructed open-ended problem that fits nicely into your premise of constructivism."	will influence how they construct an understanding through class discussions and interaction. If the problem statement is handed out after the students have constructed some conceptual understanding of the Communications concepts: they will be encouraged to reference their own mental models of this understanding when designing a solution to the ill structured problem. The open-ended nature of the problem statement allows or accommodates a variety of solutions. There is not obvious answer.
Providing support / scaffolding when engaging with problem	Facilitator's role	"I think the fact that the facilitators should be available to provide scaffolding is extremely important. The students shouldn't, they shouldn't start working and then be left floundering." "… the fact that you were on hand; we could ask you something, it didn't slow down the whole process, we could ask you a quick question; we moved on. It's not something we have got to ponder and sit and try and work out."	It is advisable for the facilitator to be available to guide the students. The open-ended nature of the problem statement may disorientate students. These students may require guidance from the facilitator to avoid becoming disillusioned. It is advisable that the facilitator provides timely guidance.
	Flow-diagram	"Sandra and I enjoyed working on a flowchart. Just sorting out the questions first and then just get a mental picture on paper and with all the layers what that mean. The flowchart proved to us that if we express it this way that that would be a logical next step. It actually led	Cognitive load?

		us in the direction of getting to something that would be able to answer different questions regarding different things."	
	Free to ask questions	"… you need to establish that the students must ask questions when they want to ask questions. Because what the question does, is it gives you an indication of their understanding, and you cant really scaffold appropriate unless you know what they know, and the way in which you know what they know is they ask a question and as soon as they ask you a question you know what they are thinking and then you can scaffold appropriately. So that is very important that they will have the freedom to get up in class and ask you the question."	Even though the students are required to design and develop and expert system on their own with reference to an ill structured problem statement, they should be encouraged to pose questions and request guidance from the facilitator. This will give the facilitator an indication of what sort of scaffolding the students require. This will place the facilitator in a better position to asses the students' cognitive understanding.
	Just in time	"What happened was that that was just in time, it was just at the right moment that you did that. The learning was easy then because you weren't trying to learn software using some abstract scenario to build something. You were learning functionally, you know that this is what you need to do and you going to use software and now we are using the software to try and achieve something specifically."	The problem statement was presented to the students after they had been given an opportunity to work through a worked example. This placed them in a better position to formulate / undertake / develop a solution to the problem. This provided them with insight into how to approach the ill defined problem.
	paper-based	"… the fact that it is on paper so that you can go back to and refer to it again. Because as we went along we wanted to go back and consult it again because you build on your own understanding, it's levels."	The problem statement provided a reasonably detailed amount of information that students could refer back to when exploring their own understanding when exploring possible solutions to the problem.
	Scaffolding	"I think we probably moving in the right direction by having a very broad, almost undefined introduction. And then scaffolding your way toward a more defined problem	Providing background, conceptual information to allow the students to gain a greater insight into the problem. Progress toward a more

		setting, more defined definition of what the outcome is. I think that's a good way of doing it." "So it makes the learning easier because you have got in mind what you want to get out of the system and now you are learning how to do that quickly, it was just the right moment. That made today's exercise much easier because now I could actually sit down and use your software to do my mental representation." "I think the fact that the facilitators should be available to provide scaffolding is extremely important. The students shouldn't, they shouldn't start working and then be left floundering." "… you need to establish that the students must ask questions when they want to ask questions. Because what the question does, it gives you an indication of their understanding, and you cant really scaffold appropriately unless you know what they know, and the way in which you know what they know is they ask a question and as soon as they ask you a question you know what they are thinking and then you can scaffold appropriately. So that is very important that they will have the freedom to get up in class and ask you the question." easily	focused problem once background to the problem has been provided. Working through the examples provides the students with insight into various ways to address the problem without providing them with definitive solutions. The progression from working together with the facilitator to develop a simple example to working in small groups to design a solution to an ill-defined problem. Facilitator on hand to provide timely support. Facilitator can gage the level of scaffolding required by the students through the questions that they ask. The leaning environment must encourage the students to ask for assistance when they need it. Even though they are required to design a solution on their own, they must be given the freedom to ask questions when they require assistance.

Focus group 9

Category	Codes	Quote to support creation of category	Comment
Engaging with the expert system	Code statements	"I struggled with the fact that we did the coding …y our taught us the coding that we will have	A lack of exposure to a programming environment leads to

shell		to use about two or three weeks prior to today and suddenly I had to make that shift again and it was there vaguely but I struggled just to get that in place and that took time, to understand how to do the coding again using the program." "I made notes the last time that you showed us to do the IF and the THEN and the questions etc, and now my notes two weeks along the line does not always make sense to me as it did at that stage. So I agree with Eunice; if following period if I had used that and done that then I would have remembered and also if I do it myself then I would have seen ok this is how it works or this is a problem, call you; you showed me." "My problem just now is that I don't know where to put in the IF statement I understand that I have to do that and then it's going to show there. And another thing, if it doesn't work I don't know where to go back and look for the problem to correct the problem. If you talk about it making sense and on paper … .But then I don't know where to find that. I can't remember." "I have to do it myself; I saw what Eunice did but for me because I'm not used to this and I'm right brained totally. For me what would help is if we did it immediately afterwards and I hade notes and the facilitator on hand and I could do it, try it myself, and if I make a mistake I ask you and then rectify." "And then during the next period I will have to	confusion. Too much time lapsed between the demonstration of inserting code statements in the expert system and when the group needed to develop their own expert system. Even notes did not make sense to some learners. The facilitator needs to be on hand to provide assistance when the students begin to interact with the expert system shell. One must not assume that the students will fully remember how to insert coding statements and how to structure coding statements. The facilitator must be aware that students may not be familiar with coding conventions or concepts and must be on hand to assist.

		do it again otherwise if time lapses, gone out of my head."	
	Hands on	"I have to do it myself, I saw what Eunice did but for me because I'm not used to this and I'm right brained totally, for me what would help is if we did it immediately afterwards and I hade notes and facilitator on hand and I could do it, try it myself, and if I make a mistake I ask you and then rectify." "…doing it for yourself is the best way because if you make mistakes you learn from your mistakes because you have to do it over and over because you have to get it right." "I would also recommend to the students that there is not only one person doing the typing because when I was following what Gerhard was doing sometimes you lose his line of thought but as soon as I started doing the second one on my on then it really settled in my mind."	The practical development of the expert system is important for the understanding of expert system logic. The concepts are not fully grasped when members of the group are simply observing the development process taking place. Learning is enhanced when students are encouraged to be directly involved in the development process. Students may not full understand the concepts being explored unless they are directly involved in the development process. Mistakes force the learners to revisit, not only the coding syndic, but also the logic of their expert systems. Students learn from these mistakes and revise thinking.
Representing understanding using an Expert System	Aggregate of options	"Remember last week I made the comment, I was kind of unclear about this expert system thing until I started seeing that if I select this and I select that and I select that what the response is at the bottom and then what I got here… remember what we did was to say, the setting is informal and the subordinate and then our display was that the setting was formal and the subordinate, which is not and expert system its just an aggregation of what your selections were at the top so we then understood that the question needs to be different and that the program needs to have	It is important that the students understand what an expert system is. It is not a summary of various options selected but involves inferences made as a result of options selected. The display line or output of the expert system will indicate whether the students have understood the logic of an expert system. It seems to be common for the developer to presume that the advice offered by the expert system involves an aggregate of

		some kind of intelligence that interprets your response and gives you an expert answer."	the options selected by the user. The concept of an inference engine needs to be carefully explained.
	Faulty logic	"… that we did today I found very useful because the previous times Sandra and I did a flowchart and the actual, I don't know what to call it, the coding, it showed us the faulty logic in certain instances." "…because we made a mistake with our coding and we also had to re-visit our logic but not only the logic of the programming language but also the logic of our CMAPP structure. Does our opinion make sense?" "What I noticed where I saw that higher-order thinking was definitely taking place was that this particular group realized that that the one question was not applicable if the other option was selected and that to me is a huge understanding of what we are doing and then they came to me and asked how do we get this to happen it won't make sense if that question is there, and that is directly related to the domain that we are exploring." "…because we made a mistake with our coding and we also had to re-visit our logic but not only the logic of the programming language but also the logic of our CMAPP structure. Whether our option do make sense."	The development of the expert system using CourseLab as an expert system shell demonstrated faulty logic. The development process encouraged the students to examine the logic of their expert system design more closely. The faulty logic is revealed during the development process. The development of the expert system revealed errors in thinking and often extended the thinking process. Because the students have to apply the design, often faulty, incomplete or deficient logic is exposed. Even mistakes made during the coding process encourage students to re-explore the logic of the domain. The learner (developer) would need to examine both the code and the flow of logic applicable to the domain in order to discover the reason for a particular output (result, consequence).
	Flow-diagram	"It helped us to develop in the IF THEN of an expert system: so we had to go back to the underlying rules and make sure that those were in place."	The flow-diagram lays the foundation for the development.

	Higher order thinking	"I think it's absolutely higher order thinking because if you are solving problems the whole time, regarding your logic in the programming side but also the logic in the CMAPP, the communication theory side." "… everybody is talking about the software; nobody is talking about a conceptual understanding of the model. So that is not happening at this stage, higher-order thinking about what the model looks like is not happening." "At that stage when you are working on the display line and you start reflecting about what an intelligent system is and how you have got to ask the question to get to the response … to get the appropriate feedback kind of thing. I think at that stage your higher-order thinking is going to be quite a lot at this stage, I'm not to sure." "The reason why I made the comment that higher-order thinking about the model is not taking place here is because nobody mentioned it; I actually listened for that. Everybody is talking about the program issues here so maybe higher-order thinking about the program but not about the model." "I think once you get to the display side of this exercise and you start really seeing what your choices above do to your feedback at the bottom that's when you really start getting the interrelationships between the questions that you are asking and the final influence it has on your message."	Constant problem solving encourages higher order thinking. Revisiting programming code to discover faults or to determine why the program is not working as it should requires constant problem solving. Becoming familiar with the development environment detracts from the conceptual exploration of the domain. (does it? Does revisiting the programming logic, etc. not force a close examination of the domain?). Working on the inferences that need to be drawn by examining the choice combinations is where the bulk of the higher order thinking takes place.

Focus group 10

Category	Codes	Quote to support creation of category	Comment
The expert system shell functioning as a cognitive tool.	Broad understanding	"… how has that modified your understanding of a formal context? Eunice: It has, because I would say formal is, formal is if the people wear suits in an office that would be the off the tip of your tongue's answer that you would give. But formal can take different shapes and a student could … or someone approaching the expert system could come with a specific idea what they have seen, so will the expert system be able to give advice based on that because there are so many variables and factors that come into that." "I think at this level when you start coding that kind of stuff, that's perhaps the learning that's going to take place. It's about what things to look for if you look at formal and informal, what kind of things in real life, if you are in a setting what kind of things are you looking for to decide whether that's informal or formal. Because that influences the question that you are going to ask."	The complexity of the domain becomes apparent through the process of developing an expert system that is designed to mimic the expertise of a human expert. This design and development facilitates a deeper exploration of the domain. In order to formulate appropriate questions, the developer needs to have a certain level of insight into the subject domain. The developer needs to explore the subject domain in order to formulate appropriate questions. This insight is further explored and enhanced when the developer is required to infer advice from combinations of answers.
	Cognitive tool	"So the reason why I think that people need an expert system is to tell them be very basic, if you do this then go on to this or this means … if you choose a suit then it is formal. So obviously people will learn something else not just the programming of that."	A tool that facilitates the learning of a subject domain.
	Faulty logic	"… we worked on the flowchart beforehand because that made sense to us. But when we started working on the programming we saw that there were some flaws in the flowchart	Developing the expert system using the expert system shell facilitates a deeper exploration of the subject domain. This

		that we did in the beginning." "For me still this works better to initially just pinpoint the questions for myself and then what I think should work and then when we do it and see that it doesn't work then we can go back and say ok why didn't that work was there something wrong with our questions here or the IF THEN statements." "… what was missing in the flowchart? Sandra: Maybe it was the questions, there wasn't a specific IF THEN statement to get to an event in the end, and I think that was maybe the problem." "What I found was that I got stuck at a certain question and then I realised that I am actually almost giving them multiple choice. Choose one and then the next but real life does not work like that."	development facilitates a closer examination of the logic expressed in the initial design. Deficiencies in the logic of the flow-diagram are revealed when they undertake the development of a functional expert system. Need to realise that the expert system must not just give you an aggregation of the options chosen but need to make an inference the way a human expert would.
	Higher-order thinking Reflect on learning	"… what's brilliant about the expert system is that students have to reflect on their learning, so its not just … yes they create a database of information but if they get this right they will turn this information into knowledge that they can apply. So I think that this makes this like constructivism, higher-order learning. Its not just learning a collection of information they have to infer knowledge to arrive at a decision."	The development of an expert system that facilitates a process of reflection. Students have to explore their understanding of a subject domain. They apply their understanding to the development of a functional expert system. Construct a representation of their understanding. This encourages them to reflect on the subject domain.
	Logical thinking	"… how is this influencing the depth of understanding that you are achieving? Sandra: Umm, it did because I'm not a logical	Forces you or encourages you to think logically about a particular subject or concept. The development of the expert system

		person but if you struggle a little bit then you understand if you do this then this will happen if it doesn't happen then it means something is wrong; then you have to go back and find out why and think but why didn't it work. What went wrong, so I think that there is learning in that." "You have got to go back to the real-life situation and think, what would they see there and you would have to make provision for that. And also if I worked through the whole thing it would be IF THEN IF THEN but I could only work on the one leg of formal and that would disregard any other choice that the students would have made and we would have had to do a whole different level which I'm not sure we would have approached that." "Gerrit told us that Gerhard and they worked basically; you put in your IF THEN statements from the bottom so that you don't have a choice. So the logic developed and my ideas of the concepts developed also. And I also got and aha moment about OK this is what an inference engine should be doing." "… what happened to me in terms of learning about the model itself and the components of the model once we had the aha moment of what an inference engine really is then it forces you to start looking back at what it is that you are looking for to decide, for example, that the tone is formal or the tone is informal. Umm, and once … what happens then it forces you to pay attention to what the fuzzy indicators of formal or informal."	highlights faulty or illogical thinking. Explore the gaps in you logical understanding of a concept. Encourages the developer to visualise or explore a real-life or authentic situation. The logic that an authentic situation would demand or impose on an individual's understanding. A certain amount of logical thinking would be necessary if an individual engaged with an authentic situation (Function successfully within an authentic situation). Expand thinking to include the logic that a real-life would demand of an individual. Exploring the logic necessary to develop the expert system encourages you to explore your conceptual understanding of the domain. New way of looking at or thinking about a subject allows the developer to make unexpected discoveries. The understanding or realisation of what an expert system is allows or encourages the student to consider the subject domain with greater insight. Encourages a deeper more inclusive or comprehensive insight into the subject domain. Consider the subject domain from different

		“I think that at this level of coding that's where the learning is going to take place. I predict that the interdependencies between the different components in getting to your final product, I think that is going to become apparent right at the end when you start working on your display line.”	angles. Formulating the content of the display line is where the real deep learning is going to take place.

Addendum B

Research participant information sheet-Students

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education
Office of the Dean

Research participant information sheet

INFORMATION COMMUNICATION TECHNOLOGY AS A COGNITIVE TOOL TO FACILITATE HIGHER ORDER THINKING

My name is G W Collins and I am currently conducting a research project, the purpose of which is to reflect on the design process followed when developing a learning intervention that uses an expert system shell to model understanding in order to develop higher order thinking skills. Before you agree to participate in the project you should fully understand what it is all about. If you have any questions, which are not fully explained in this document, do not hesitate to ask me or contact me, my supervisor or the Chair of TUT's ethics committee at the following numbers:

- **Gary Collins** : Tel. 082 518 6600; collinsgw@tut.ac.za
- **Dr WA Hoffman** (Chair, TUT's Ethics): Tel. 012 382 6246; hoffmannwa@tut.ac.za
- **Prof J Knoetze** (Supervisor): Tel. 012 420 2886; jknoetze@mweb.co.za

WHAT IS THIS PROJECT ALL ABOUT?

This project is about reflecting on the process involved in the design and development of a learning intervention that uses technology as a cognitive tool in order to facilitate the development of higher order thinking skills in foundation English Communication Skills students at TUT. The reflection will be concerned with the process followed by an instructional designer when designing this learning environment. This reflection will lead to the formulation of design principles. These design principles will include the essential characteristics of the intervention as well as a description of the process that might be followed in order to design and develop a similar intervention.

WHAT WILL YOU HAVE TO DO IF YOU ARE PART OF THE PROJECT?

You will be asked to participate in a learning program that requires you to use technology as a cognitive tool in the form of an expert system shell. You will then be asked to fill out a questionnaire, after which a group discussion will be held to obtain your impressions of the computer assisted learning experience.

WHAT BENEFITS WILL THE PROJECT HAVE FOR YOU AND OTHERS?

The design principles that will be formulated will serve as guidance for instructional designers and lecturers who wish to design and develop a learning environment under similar circumstances. A copy of the final thesis will be provided to the TUT Dean: Humanities and the TUT Director: Teaching and Learning with Technology for notification and implementation of the research findings.

THE RESEARCHER'S ASSURANCES AND COMMITMENTS

Participation in this project is voluntary. You are free to withdraw your consent to participate at any

time without having to provide any reason for your decision. Withdrawing your consent will be accepted without any penalty or future disadvantage.

All the information that you provide during the project will be handled and stored confidentially. This means that access to your data will be limited strictly to the researcher. All personal identifying data will be removed/masked on transcriptions and all project documents. Your identity will not be revealed during or after completion of the project, even when the results are published or used in any format.

If you so wish, I shall be glad to give you feedback regarding the analysis of your data and the overall analysis of the project.

Non participation in this project will not have any detrimental influence on your academic assessment in any course.

All parts of the study will be conducted according to the internationally accepted ethical principles of qualitative research.

A LAST REQUEST

The researcher would like to request your permission to do the following during and/or after the study, namely to:

- audio-record our interview/s for data analysis; and
- use direct quotations from our interview/s in the final project report, journal articles and/or other formal presentations of research results.

If you are still willing to participate I shall be glad to make specific arrangements for the research interview. I will then require from you to sign an informed consent document as a formal acceptance of the information contained in this information document.

Building and office no: T09
Groenkloof Campus, University of Pretoria
PRETORIA 0002
Republic of South Africa

Tel number:012 420 5627
Fax number: 012 420 4215

E-mail address:rose.tibane@up.ac.za
www.up.ac.za/education

Addendum C

Research participant information sheet-Design Team

Research participant information sheet

INFORMATION COMMUNICATION TECHNOLOGY AS A COGNITIVE TOOL TO FACILITATE HIGHER ORDER THINKING

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WHAT IS THIS PROJECT ALL ABOUT?

This project is about reflecting on the process involved in the design and development of a learning intervention that uses technology as a cognitive tool in order to facilitate the development of higher order thinking skills in foundation English Communication Skills students at TUT. The reflection will be concerned with the process followed by an instructional designer when designing this learning environment. This reflection will lead to the formulation of design principles. These design principles will include the essential characteristics of the intervention as well as a description of the process that might be followed in order to design and develop a similar intervention.

WHAT WILL YOU HAVE TO DO IF YOU ARE PART OF THE PROJECT?

You will be asked to work through a tentative design of a learning event that uses computer technology as a cognitive tool in the form of an expert system shell. You will then be asked to participate in the pilot design of a questionnaire that will be presented to the student sample, after which a group discussion will be held to obtain your impressions of the computer assisted learning experience.

WHAT BENEFITS WILL THE PROJECT HAVE FOR YOU AND OTHERS?

The design principles that will be formulated will serve as guidance for instructional designers and lecturers who wish to design and develop a learning environment under similar circumstances. A copy of the final thesis will be provided to the TUT Dean: Humanities and the TUT Director: Teaching and Learning with Technology for notification and implementation of the research findings.

THE RESEARCHER'S ASSURANCES AND COMMITMENTS

Participation in this project is voluntary. You are free to withdraw your consent to participate at any time without having to provide any reason for your decision. Withdrawing your consent will be accepted without any penalty or future disadvantage.

All the information that you provide during the project will be handled and stored confidentially.

This means that access to your data will be limited strictly to the researcher. All personal identifying data will be removed/masked on transcriptions and all project documents. Your identity will not be revealed during or after completion of the project, even when the results are published or used in any format.

If you so wish, I shall be glad to give you feedback regarding the analysis of your data and the overall analysis of the project.

Data collected will not in any way be used or released for promotion and/or performance evaluation purposes.

All parts of the study will be conducted according to the internationally accepted ethical principles of qualitative research.

A LAST REQUEST

The researcher would like to request your permission to do the following during and/or after the study, namely to:

- audio-record our interview/s for data analysis; and
- use direct quotations from our interview/s in the final project report, journal articles and/or other formal presentations of research results.

If you are still willing to participate I shall be glad to make specific arrangements for the research interview. I will then require from you to sign an informed consent document as a formal acceptance of the information contained in this information document.

Building and office no: T09
Groenkloof Campus, University of Pretoria
PRETORIA 0002
Republic of South Africa

Tel number:012 420 5627
Fax number: 012 420 4215

E-mail address:rose.tibane@up.ac.za
www.up.ac.za/education

Addendum D

Informed Consent Form

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education
Office of the Dean

INFORMED CONSENT

INFORMATION COMMUNICATION TECHNOLOGY AS A COGNITIVE TOOL TO FACILITATE HIGHER ORDER THINKING

Researcher: Mr G W Collins, Department of Applied Languages, Faculty of Humanities, Tshwane University of Technology

*Instructions: Complete all the questions in this document by marking (**X**) the relevant block in each question. Then sign your initials at the bottom of page 1 and provide your full signature in the relevant place on the second page.*

1. Have you read the Research Participant Information Sheet?

YES	NO

2. Have you had an opportunity to ask questions and discuss any unclear project issue with the researcher?

YES	NO

3. Do you understand that participation in this project is completely voluntary?

YES	NO

4. Do you understand that you are free to withdraw from the project and/or interview/s at any time, without having to give a reason for withdrawing, and without any penalty or future disadvantage?

YES	NO

5. Do you understand that all the information you provide during the project will be confidentially handled and stored?

YES	NO

Building and office no: T09
Groenkloof Campus, University of Pretoria
PRETORIA 0002
Republic of South Africa

Tel number:012 420 5627
Fax number: 012 420 4215

E-mail address:rose.tibane@up.ac.za
www.up.ac.za/education

6. Do you understand that you will not receive any monetary or other form of reward for participating in the project?

YES	NO

7. Do you agree to take part in this project?

YES	NO

_____ _____

Research participant's signature Date

_____ _____

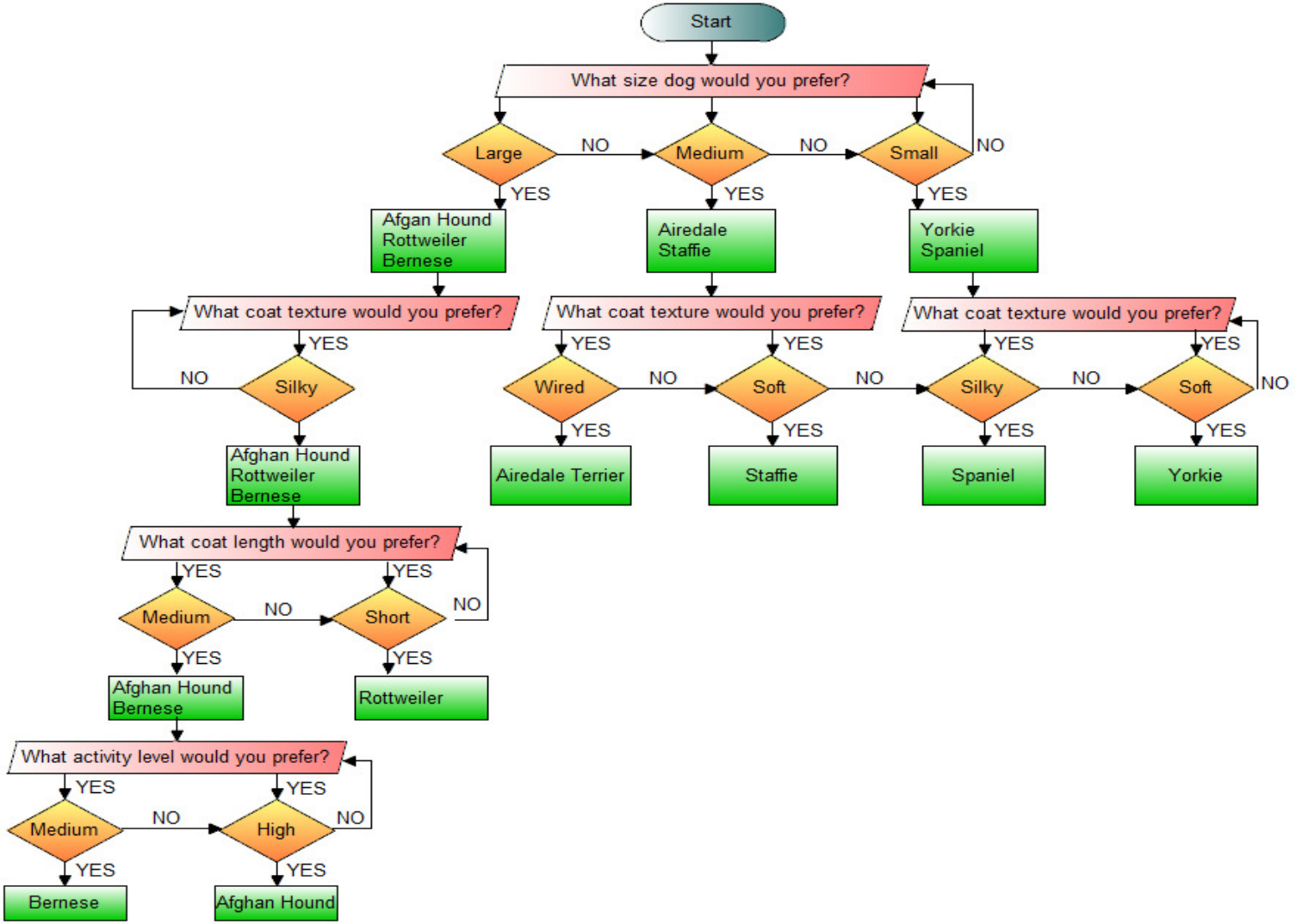
Researcher's signature Date

Building and office no: T09
Groenkloof Campus, University of Pretoria
PRETORIA 0002
Republic of South Africa

Tel number:012 420 5627
Fax number: 012 420 4215

E-mail address:rose.tibane@up.ac.za
www.up.ac.za/education

Addendum E


Start
What size dog would you prefer?
Large
NO
Medium
NO
Small
NO
YES
YES
YES
Afgan Hound
Rottweiler
Bernese
Airedale
Staffie
Yorkie
Spaniel
What coat texture would you prefer?
What coat texture would you prefer?
What coat texture would you prefer?
YES
NO
Silky
Wired
NO
Soft
NO
Silky
NO
Soft
NO
Afghan Hound
Rottweiler
Bernese
Airedale Terrier
Staffie
Spaniel
Yorkie
What coat length would you prefer?
Medium
NO
Short
NO
Afghan Hound
Bernese
Rottweiler
What activity level would you prefer?
Medium
NO
High
NO
Bernese
Afghan Hound

Addendum F

Transcripts of the focus group interviews held with the design team

(No editing of responses)

Transcript of focus group interview held on 20 January 2011

I: Ladies and gentlemen, initial impressions of what we've just seen; who would like to begin?

R2: Well, I must tell you that this is quite an interesting topic and I think that it is quite a challenge for you and whoever is going to work with you. I think that your problem that you want to solve, the problem that we are encountering here at TUT, is relevant and the idea that you have is very interesting, something new and it's a challenge as I've just said. For me to be more practical, I think I understand your thinking pattern, I understand where you come from. The only thing is that I would have liked to see how the expert system functions, but we'll do that next time that we meet. Those are my initial impressions.

I: OK, what possible challenges do you see?

R2: To me it is still a little unclear, 'cause I see that it is still a little unclear for you as well, how you will actually implement this with a group of students, so for me to make definite … . So the pitfall for me at this stage is that it is not quite clear for me. But I mean it's part of this process.

I: It's not clear for you regarding how it is going to be implemented?

R2: Yes.

I: Thanks R2. Who else?

R3: So you're speaking about pitfalls, so you will probably see it when we are going to implement it for you, so maybe you will see with us that we can't do it so I don't know how the students are going to do that. No. I just want to know about the material that you are going to use and that what you are using… What I'm trying to understand here is that you are going to give them information, not information that they already know about but something that they should know something about but then develop as they go on to … in order to get them to a higher level of thinking. The material that they are working with, they must understand at least a bit about what is going on, otherwise I think they will not be able to … you know, ask the right questions because I see that your expert system, you have to ask the right question, you have to think about the right questions as well and if they don't really understand, I think maybe … although on the other hand if they don't understand they might ask relevant questions and get to the answer that you need.

I: And your initial impressions?

R3: No, I think that it is a very interesting concept, I'm totally technology challenged so if I can go through this I'm sure that your students will be able to do that as well. No, but I think that it is a very good concept, I think that you have a very good thing here, something that when you are done, sell it to other universities or something but I think that it is something that can be used. The problem maybe is now for your class, that the thing with technology is, the problem the way I see it is that not everybody has access to technology, so now the students are going to be in class; so now if you are going to

use this probably it is going to be in the university where there are facilities etc. available.

R4: I think that it is a very exiting research that you are doing because if you take a look at the context we are in at TUT and the challenges that we are faced with and the students who we teach I think that we are currently stuck in using technology in a way that will just perpetuate the problem, the behaviouristically based software and not replace what they are doing. So I think that it will be very exciting, I think that the most exciting but for me will be to see how the students respond to it and if there is resistance and if once they realise that if they are going to work on this and build this, how they will respond to that. Although I think that once they pass the first obstacle, I do expect to see that they are going to enjoy it. And it is maybe going to change their perception of their own abilities and I think that is important because I think their awareness of what they are able of will be challenged so some boundaries will be shifted there.

R5: I think that the biggest challenge would be the implementation in terms of contact time, as R4 said they will only have access to computers and hour and a half a week and that's it. Most of the Soshanguve students don't have computers at home. So that's going to be the biggest challenge I would say. And what I remember last year we worked for about two weeks with the expert systems and the response from the students was amasing at that time, I think that it is exciting and the students are going to enjoy it that's for sure. And the last thing I think that it is crucial at the university level to implement it, I think that it is great because I think that it is something that is always a problem… I think that it is the purpose of a university is to get them to start thinking, it's actually too late but at least we can try.

R6: I'm also very excited about Jonassen's mind tools and the expert system is one of the mindtools that he encourages lecturers and teachers to use. And I was introduced to the mindtool concept a few years ago, we worked on creating an expert system to identify birds and that really helped; I mean the birds that we had to identify, their characteristics still stick in my mind so I think that it is an excellent way of learning because creating an expert system goes hand in hand with doing research and discovering information itself. So I'm also very excited about this it's just to create the shell now of how to implement this in class, how are we going to go about doing that, but like R5 said we did two years ago as a short trial run and there are definitely possibilities.

I: What are the main challenges?

R6: I think the main challenges are the time and access to computers, as R5 said, and creating the shell and also having enough time for the students to be able to create the expert system in class, but I think that that can be done.

I: Thank you all very much.

Transcript of focus group interview held on 2 February 2011

I: Just general impressions of what we've done today.

R3: Okay, I think that the students would find it very interesting. It is a new way of learning to them. It's not something they're used to. I also think that they will enjoy developing something for themselves, instead of being given something as per usual in the classroom.

R6: I think if you are going to use IT students, that's probably going to be a good selection, given that they need to work with a little bit of programming logic, because they might be a little bit more familiar with the programming logic than the kind of general student. I know with us we kind of have a basic idea of what programming logic is, but not really enough to do something constructive with that, but if they are IT students, they might have already encountered stuff and they might have learnt how to write that into a program so they might be a little bit more aware of syntax per se of the programming logic whereas we are just familiar with the concept of programming logic. So I think your selection is a good one.

I: But if the selection was different?

R6: I think you will battle if you work with logistics students, for example.

I: We need to find a way of overcoming that obstacle.

R6: Yes

R3: Just a concern of mine, is time. Time. Because one always under-estimates how long this would take and I think even to the students … even if they are IT students it might be a totally new concept. So time … you'll have to consider that very carefully.

R6: I think you should also consider having it facilitated face to face. Rather than working off a printed sheet. Because what happens then, is if you do step-by-step and they have to follow you step-by-step as soon as there's an issue they you can actually go and address a specific question that they've got. And I think the variety of problems that you will encounter will be quite vast, so to trying to cater for everything on a handout is kind of

difficult. You might give this to them as a reference for later on. But the first time they encounter that you actually facilitate a simple example but on a face-to-face basis. And as we spoke earlier perhaps on that campus if you use "Netop" might be a good way to do that.

R4: Some students might run ahead of the others as well in their own time.

R5: I think also many of the IT students who are doing communication now, some are 3rd year. 2nd / 3rd year generally, by that time they already know programming logic. So I think they will … that they will not struggle that much. But let's say a group of logistics students might struggle to grasp the concept of programming logic, but I think just to support them, give a hand out but also maybe go through it step by step in class as well; to pre-empt any problems that they might have.

R6: That's just a further comment about a handout, is given that group of students, for example, if you test their language proficiency it's not really that good. And then to give them a handout with proper English written on it might not be that useful to them.

R3: Yes, and I also think there's the terminology used in the handout, might be an obstacle. You'd need to explain that sometime.

R5: Maybe more graphics and fewer words maybe. Yes, I haven't thought about it, but it might be a problem.

R6: And really simple language and you're going to have to predefine terms all the way. So if you want to use variable, you will have to tell them in simple English what a variable is. With an example. That's why I'm saying if you are going to use paper, you will end up with quite a hefty manual if you have to predefine everything and give the examples. Even if you explain to them what a variable is, it's still not going make sense until they

see an example. Not the IT students as much, but the broader population is going to have difficulty with that.

R5: Generally the handout is a good idea, I think. Step by step guide to take them through this, because I'm also not that clued-up. Definitely not on programming and this is really … it does help. And I did this two yrs ago and I've forgotten a lot and this really helped me to remember what I did 2 yrs ago. So it's a good idea.

R3: And especially if you regard that this will be the tool to design the expert system in the end. It shouldn't be an obstacle. They should have a handout for reference later on. You explain and then in their own time they can come back and look it up again.

R4: I think, also, something we should consider as we go through this process. In what way are we using higher order thinking? Because that's what it's all about in the end. So maybe that's just something to consider when we go through this process.

I: So besides the handout and R6's suggestion of a face-to-face demonstration, what other tools can I or we use to overcome the obstacle of getting to know the expert system shell?

R6: Remember that we get the Camtasia recording, so screen capture because maybe if we do the screen capture and we can split that into little bits so that you've got the first page of stuff in a little screen you can play a little bit and maybe you can make that work as well.

I: So you suggest that the screen capture is coordinated with the handout?

R6: Well, not necessarily coordinated, bit just broken up into little bite sizes. So that then you do like a meaningful bit on the screen capture and then there's a logical break in the screen capture so they can go back and do that. That significant … that meaningful little bit and then go back to the screen capture and have a further look and go back and do that again. Might help when … you know if they do forget then they've got an assignment and they've got to go and refresh and… what the students do is, they sit in class and they nod seemingly intelligently and understanding, but they don't really, so if you can give them something that they can kind of play with later on.

R4: I think that logic gap is important that you're mentioning. Otherwise, it's just following instructions and reading skills. That's what we want more that that. So, yes, I like that logic gap.

R6: One thing I found about learning software that I found about myself, is that the first time I encounter new software … even when I work through an example, it's not really the most effective way of learning if it's not reinforced later on ;you actually don't learn the software. So we all learn software that way, you go and you work through an example, but all that really does, it kind of gives you an idea of how the software works, but the time when you really start learning the software is when you do something that is meaningful. You know, so if you've got an assignment, you now have to use the software to do stuff with it. That's when you really learn the software. So if they can have like just a tutorial, just to understand what variable means and how to put a textbox on the screen and you know where the … exactly how the user interface is structured kind of thing. So a bit later, when they have to go and figure stuff out, they're not completely lost. But this initial tutorial, I think you'll have to go and follow that up with giving them an actual project to go and do at home or something so they can figure stuff out.

I: A well-defined project?

R6: I wouldn't do … your whole project I would approach like this. I would start from the simple and progress. So the demonstration that you do has got to be really the simplest kind of problem that you can give them that will incorporate all the software elements. So just to show them what everything means. All the tools and icons on the software mean. But not a difficult problem because then they're going to start focusing on the problem. And they are going to get themselves lost in the problem and not focus on the software kind of thing. So I'll start with a simple problem and then perhaps progress to a bit more complex problem. And the more complex the problem becomes, the more you are going to start kind of focusing on the problem and not as much on the software. So you want to start off with them learning the software but then as you progress throughout your term as the problems become more complex your cognitive load is going to want shift towards the problem-solving and not as much as to the mastering the software and I think that's what you actually want do, you want to have them focus on the problem. I don't think you should start with a complex ill defined problem, rather just something simple just so that they can see how the software works and then go from there.

R4: On that note I was wondering if it is possible to apply the expert system in an abstract problem. Does it have to be "Yes" or "No" answers? Definite? Just something I was wondering about because we keep on simplifying our thoughts to be able to put into an expert system.

I: I think that it is important for us as a group to determine what can be modelled by an expert system and what can't. But I think we will get to that when we tackle the actual subject matter itself.

R6: And also whether the expert system has the capability to program fuzzy logic. If it hasn't got that inbuilt ability to deal with fuzzy logic that means that what ever variations of "Yes" or "No" you want you are going to have to build that in, so do you want a medium dog a little bit smaller a little bit bigger. If you want that kind of logic built into the program, if fuzzy logic is not kind of part of the inbuilt capability of the software, you are going to have to kind of have a range of pictures and ask them to click on the little bit bigger little bit small, you are going to have to program that in, which means your program itself becomes like fairly complex.

R2: Are the students themselves supposed to be able to program anything?

I: Yes, this development environment is incredibly simple, obviously for a complete novice it appears not to be but it's very, very simple, that's why I chose it as the shell.

R2: But do they have to program?

I: In broad theory, yes, but in reality it's just you have to learn the syntax and you have to know one or two syntax rules and the rest is just pure logic.

R2: That's where the problem comes in.

I: But we didn't get that far today, I would have liked us to have got that far but we didn't but …

OR: I think that in terms of the context-based critical thinking that's going to happen is going to happen when you draft you flowchart. What's nice about then moving your flowchart onto the software is you are actually

going to make your assessment of the programming logic a little bit easier. Because if you assess their program logic, all you need to do is to go to the program and see if it works. Because then you know the program logic is kind of appropriate. But I think the problem-solving is going to happen on the piece of paper and not on the software. It's not going to happen when you develop the program on the computer; that's not where the critical thinking is going to happen, it's probably going to happen here. Or what will happen there s once you build your software you will see, oh but this doesn't work so that becomes also … almost a kind of Vygotskian interaction, where somebody says, "Oh, but this doesn't work" and that refers you back to revisiting your construct, and seeing OK, now we have to modify the construct here and then you take it back to some kind of independent adjudicator which is the software which shows you whether it works or not; if it works then you are happy; if it doesn't work it refers you back to your programming logic. I think that's a valuable role that the software is going to play. But in terms of the logical design I don't know whether that is going to happen. I don't know … when I work... when I get stuck on the computer I actually work it out on the computer kind of thing, so during the process of designing your flowchart you are probably going to use the software to do minor tweaks if it's a major tweak you are probably going to go back to your flowchart, to redesign your flowchart. This is the flowchart where a lot of your critical thinking is going to happen.

I: Another question I would like to ask you guys before I let you go is, are we starting in the right place? Is there another place we should be starting? Should we be giving them more of something before we get into the actual development learning the software, designing the algorithms and things?

R6: I would start with the flowcharting; consider doing that pen and paper based umm and just showing them what a problem-solving process is. Show them how to do problem-solving and then also once they

understand clearly defined problem-solving move them on to ill defined problem-solving just so that they understand the problem-solving processes and from there on you can move on to a proper flowcharting of the process and from there on onto the computer. I wouldn't try to do all that in one step.

R4: On the issue of time, maybe use some of the other periods to do the planning as well, not only the lab session; I think that would be a good idea.

I: Anything else? OK, thank you very much.

Transcript of focus group interview held on 4 February 2011

R2: Okay, I'm not a programmer and I know nothing about it. What worked for me is to first put things on paper. Like it generally works for me in any event. You write things out and see how it works out there and then from there on you show us the tutorial. If it makes sense then, I think after that then the students must do it themselves, but I think the main thing is to start with a simple one like here in the beginning when it's only two options so that they can work it out. First chronologically for themselves. If they can do it here on paper, then it should be easier for them to transfer it when they see what they are doing and then they can do it themselves on the computer.

So, I think, yes, start a simple one and then add. I wrote in the first class depending on your students; have the second question added there as well. So I understood that for me, who knows nothing, it took a while to grasp what's going on. So I understand for the first one … I understood the second question … putting the second option there as well, I think for

the first class, just do the basics first, and one question, and a simple algorithm and then build on that further.

I: OK, you were a little daunted the first time we spoke about programming; do you feel less so now?

R2: Yes ha ha ha!
Yes because if it makes sense here, it's still difficult for me but you can still transfer and see what you are doing there. But for me it's easier and basic and then to build on that. First get the basics under control and then carry on with the more involved things. But just, like last week, opening and doing this…

I: … too much too soon…

R2: Yes.

I: OK, thank you.
Anyone else?
OK, I'll go sequentially….

R3: Okay, I want to agree with R2. I must admit that after our last session I was a bit intimidated. Not a bit. A lot. I know nothing about programming. And I thought I was very worried because I thought the students will find it a bit daunting. I thought there was a time issue and I think you've even addressed the time issue now. Because you've broken it down into logical bits. Which follow on each other. First the paper-based, then working on your own, then you demonstrating and I could apply what I learnt and I could see the logic behind what you were doing there because I knew what the symbols stood for. You made us work through examples which showed us which question would work and what would not work. For the

result we wanted in the end and I think um I just, for the first handout, just to refer back to that. Again, this was much simpler. The language was much simpler. The terminology … My perception was WOW with this terminology I'm out of my depth. But now the second time round, I thought I could try this. I can do this.

R1: What I've basically observed is that I think that your idea of using the system and involving the students to get to a higher level of thinking is a very huge topic. And I really wish you luck with it. But I can see that you have started working through it systematically and with the input that we got today from the delegates here. I'm actually interested to see how you are going to build it up from here. I agree with you, your pace must be slow. Especially if you go through the functions and make sure that they all see it and also that a guideline needs to be there if it needs to be double-checked on this. If there is something that they didn't see properly, I mean I'm sitting a little far away from here so it's just a practical thing. It's very small so it will be helpful for them to have this here. So umm …

R3: Screen print that you demonstrated will be very useful. Where you break down into a capture of the logical steps, because as you went through it now, it was a bit quick and if you did it in that way, it would've been easier to follow.

R6: Yes, I feel far more optimistic after today's session that this might work in the classroom. What I think you could do to get around the speed issue is to do something, and then stop and make them do it. Not to just let them watch through the whole presentation and then the first think they're going to forget again. So let them … .You did kind of decrease in the scaffolding quite good today kind of thing. In the same way the first one, step by step, do or show something and let them do it. Then the second one you kind of step back a little bit and you ask them, OK, what must we do next and

then they must do it. Then you say, OK, do this now on your own. But you can like probably break this down into about 3 or 6 stop starts, where you do something and you say, OK now its your turn. You go and build it. And I think that might work. Other than… Yes, um, I think that should work. Now I want to make a comment, just for the record. Is just remember that when you facilitate in classroom, perhaps you go ahead of time and you train your students to be more computer literate perhaps and you give them detailed training ahead of time in a smaller group and then when you give your demonstration to the larger group you can use your expert students and call them that. To facilitate the learning process so you can tell them, okay, now you go and do it. And there are like 20 guys at the same time who need help, you can't run around doing that. So if you have your 5/6 student "assistants" that might just facilitate that process.

I: OK, thanks. That was good.

R3: OK; can I just add to that. What I found very useful when you demonstrated is that I had the opportunity to directly ask you a question, immediately, when I didn't understand what was going on. Whilst if I did it on my own, I would maybe have forgotten, but the direct interaction is good.

R5: Like R3, I really think the screen freeze is very good to use. To once you've done a step just to freeze the screen and then give a little written explanation of what you've just done. But I also think that trial and error is very important because last time I sat and I got stuck at a certain point and once you have gone through the whole process slowly, it makes sense now, but just to find the correct pitch between trial and error and doing it by themselves and giving them the information that will be tricky, I think. To find the correct balance between doing it on their own and providing them with information. Because I think if you provide them with too much

information, then and without them doing it on their own, they will also feel lost. So just to marry the two, yes …

R1: The show and tell, and then the "do". If that works together and you are there to assist and give direct feedback. It could work.

R6: I think the idea of, like, battling a bit on your own is a good one from a certain stage on. I think that if you just go and dive in and you start to figure it out, that might just become a bit demoralising. But, um, if you go and you do basic example and then you give them something that they have to try and figure out on their own, and you give them a while to play with that. Because what happens in the process of fiddling, is you then discover other things which don't answer your question now but stay in the back of your mind for later on when you've got the question that needs this answer. So, to a limited extent, let them try stuff on their own for a while. For a brief while. Not too long. And then show them the right way. So that they not only learn what you teach them in class, but also that little bit extra that they discover. While they're playing around. And that portion of learning is going to become more and more important as they become more and more advanced in their knowledge of the software. So the better they get at using the software, the better they get at discovering stuff by playing around. But that's just, um. That's just because, as your foundational knowledge increases, it's easier for you to relate new stuff to it. So if you play around without having any foundational knowledge there's nothing to make linkages to. But as you build on the foundational knowledge, it becomes easier to make new linkages to it.

I: You guys have mainly told me what worked here. What didn't work?

R2: For us, for the students, maybe you went a little bit quickly. Just through that, but the rest I think worked and I agree with her that the soon as…

because I'm going to forget if I'm not going to do it now. I will forget until the next time. It's like any computer program. If you are going to work with it, you won't forget. So if they can, after each step just do it and then they should be fine.

I: Okay, any one else?

R6: And R5 is going to facilitate in the classroom. Because you are clever to facilitate to beginners because I don't think you remember when you didn't know anything. So you're still making assumptions about like certain terms. For example, you know what this term means. And you just use the term and you carry on, but if you have somebody who has no knowledge about the software, writing the manual or presenting the class, you gonna get a better match between the facilitator's language and the students' knowledge of the software itself. Because they're gonna phrase their explanation not in terms of technical terms, but they're gonna phrase it in terms of they're understanding of what has to happen. So they're gonna describe what a variable is without using the term variable. You know? You just assume everybody knows what a variable is. Kinda thing. So that will be a good match, I think.

I: Anyone else?
So do you think we've reached a point in our design where we can assume we have covered the students learning the software and understanding the expert system logic?

R3: I definitely think so because everything today was very useful.

I: And the students will be able to deal with what we've done, today?

R3: I definitely think so …

R6: I think if you take what you've learnt today just build that into your lesson, if you want to call it that. It might work. You might want to demo it onto a smaller group, just do a little bit of a pilot and check and make sure and see what you learn from that experience. But I think that you are kind of 80% of the way there.

I: All right. Thanks everyone.

Transcript of focus group interview held on 9 February 2011

R3: First off I think the fact that you gave us paper-based questions so that we had something in front of us to work with was a good idea. I think that R2 suggested that you should not hand out everything at the same time, so that there are logical gaps again. And I think that the questions could just be more specific and if you have a forum where you have face to face interaction with the students while they work that terminology should be explained and that feedback should be given after each logical gap.

I: When you say terminology, what terminology?

R3: Terminology like the word *context*, like the word *situations*, things like that. The assumption is maybe that they would know what it means, but I don't think we can make that assumption.

R2: I think what you can do there is, instead of just explaining everything ask them what their understanding is of the concepts before you start. And then break it up. And give them an example maybe of the communication situation if you want to, I know you said that you didn't, but make it something different than the context that you have there, like a corporate

environment, make it something different that they can't use. That will give them an idea of along which lines they should think, I know you want them to struggle but they should have an idea of where to start otherwise they might not know what to do. Another thing that I thought of is in the end everybody, every student is going to develop his or her own expert system so what you might find in groups of students who sit like this that they don't want to speak or that they are used to getting everything and now they have to think for themselves so that might, I don't know whether it is relevant, but it might be a problem in a group environment that one student is the bright spark and does everything and in the end when they have to develop their own then they still struggle.

I: OK, how do I involve them?

R2: I don't know.

I: So you anticipate it being a problem, though?

R2: I'm just thinking that it might be, but if the groups are small enough then it shouldn't be, you know two or three then you know you can't just sit and say nothing, yes.

R1: I just want to add to what we are saying. I think that it is important that before they do this whole exercise that you paint the picture a bit clearer. You can give them scenarios as example, you don't have to say this is exactly how I want it but it gives them a clear direction of what is expected from them, umm, I mean it helps to give them more guidelines, I mean you don't have to give them the recipe, they have to figure out the recipe for themselves here. Umm, and even if you look at the wording here it can be confusing, so make sure that what you have written there is clearer, maybe here and there a word but then before you … They know what you

are wanting to achieve instead of you telling them what you want them to achieve at the end they have to bring in their input, they have to trust in their creativity that they are going to create something that hasn't been before. You know something like that. For me it's a bit more guiding, and then when you come to this part where they have to develop the flow diagram the moment that they get there the beginning must be clear otherwise they will not be able to do this.

R6: Umm… . We spoke earlier about your need to explain what the different components actually mean if you talk about context what do you mean, if you talk about audience what do you mean by audience, so perhaps just remember when you get to the section of the questionnaire that deals with *context* that you just step back a little bit and explain exactly what you mean by *context* and when you get to *audience* just explain a little bit further. That's the one thing, the other thing I want to say and, umm, from a research design point of view from a little bit with an ethical slant, what you are saying is very true about groups, um, that everybody doesn't participate in groups and for varying reasons. Some people just don't like working; some people just don't like groups so I'm one of those persons, if you put me in a group I … and depending also on who my colleagues in the group are. If you want me to keep dead quiet put me in a group with an opinionated extrovert and I will not contribute at all in that group. I'll let the group go down knowing that they will go down, knowing that they make a mistake but I won't contribute. So groups, I know people think that groups are the most wonderful thing to use in class group because it saves them work or whatever it is, umm, it's not fair towards introverts at all. Umm. so maybe think about a way in which you can deal with people who like working in groups and those that don't like working in groups. Having said that, even introverts need to be able to work in groups so do it sometimes but not always. Umm, I was very fortunate with Johannes, he used to do that with me, he knew I hated these things so sometimes he

would just force me to work in a group and sometimes he said, “No, you don’t have to”. Umm, just as a suggestion, groups for some people are just very, very, very threatening and it will actually hinder the learning for some of them; some of them will be able to work around that, might be capable of taking this home or working this stuff out on their own, in their own time, but some of them won’t be able to. So groups are not always a nice place for some people.

R4: I was just thinking one thing as well, perhaps a good idea … just thinking about it now, is to maybe have a brainstorming session about different communication contexts in little groups, umm, but just to create the context of what to expect in the class and then getting feedback from all the groups; I think that then you already have something to work with and then you move into this question, three situations in which communication can take place; then already I think …

R1: Let them role play a situation … that they would role play a kind of situation and then you would say right, you did that now write it down, …what are the components, who are the role players? It might give them a bit more experience.

I: Might be a bit time-consuming?

R1: You can give them five minutes, ten minutes. Think about it and do it, they are very good at role-playing.

Transcript of focus group interview held on 16 February 2011

I: Perceptions of what we have been up to today?

R3: Umm, I think the face to face interaction worked very well. I think the way that we progressed with facilitation through the concepts worked very well. The segmented way that we did this and the video clips the visual really I think will draw in the students and the real- life situations, the complex real -life situations would help them a lot. I wouldn't go and give them more paper work, I would go … do the basic concepts that you did multiple choice questions etc. and then do the rest segmented, umm, with all the other concepts face to face based on the video clips again.

R4: I just want to say something there. I think what we did today worked very well but I think what we must keep in consideration as well is that we are going to sit in a class of seventy students and there is going to be a lot of … This worked well because there was a lot of feedback and discussion; now there are going to be seventy people in a class, so this again, there will have to be small groups and then feedback from the groups, and then you will have unhappy people like R6 in the group. So I think we must just think about that as well.

I: OK, so how do we overcome that, big classes, what do we do?

R4: Well, as I said, maybe small groups and then feedback from the groups. But it's not going to be as streamlined as it was today. And then what also worked well today … or maybe we should swop the two exercises from last week and this week. Do this and then go on to do maybe one example of their own, their own scenario. Exactly like last week but maybe one scenario. Because then they will know what it's all about and then move on to their own flow-diagram. That can work the two exercises together.

I: So we shouldn't abandon last week's exercises but we should maybe just incorporate them into this week's.

R4: I don't think so; and maybe just one scenario.

R1: I agree with you, what we missed last time was the step in-between and this lesson was the step in-between. From the beginning when you explained the expert systems and then the CMAPP… so it was very good and … giving some … something more sound that's not completely abstract so I think it's a good idea.

R6: Umm, the thing that I liked particularly, I like that you take context and you work through an example in detail, like we did today and you go back to the video clips and we start discussing some stuff in the video clips. And then if you guide that discussion towards, let's say product as a concept, you start talking about you know what's on the board there what … you know discuss about … without telling people that they are discussing product, you just start leading some kind of discussion on what the product is. And once they have discussed that a little bit and explored and got them to what you really want them to understand about product then you can step back and summarise for them. So you see … So when you talk about a product this is what we mean by it and you can summarise then what they have said. And you can move through … you can use different video clips to do that, you can use one video clip for product and one video clip for purpose, for example. So you take the next video clip an you start discussing the purpose without telling them that that's what you are doing and you take a step back and you summarise and you say OK, in that video clip this was the purpose so that they understand these things that they had running around in their minds now, then that goes to purpose. That's a good way of them kind of analysing the situation first and then reducing all that discussion down into a formation of a concept. That kind of was a nifty trick for me, yes, I enjoyed that.

R5: Yes, I also like the paper-based exercise because scaffolding was provided by first starting with multiple choice, just opinions and then later they had to express themselves in writing and then in paragraph form as well. So I think that it was well structured and scaffolded and also visually … real visual … the students will have real visual interaction with the videos that you are going to show and based on the videos they can answer these questions. So I think that was quite good.

I: Anything else? Umm, getting from a conceptual understanding to graphically representing their understanding in a flow-diagram, what is an effective way of doing that?

R3: Well, the way that you demonstrated it here facilitating, sort of another brainstorming session but not doing a mind map, doing the flowchart immediately. That would bridge the gap for me back again to the flowchart and show me what would be the end product, that you would expect from me, without telling me what to do and what to put in specifically. So I didn't mind that way.

I: Did that work for you?

R3: It worked well for me, the flowchart immediately.

I: Can you think of a better way of doing it?

R3: No, I don't think so.

R1: I would suggest that... depending on the need of the student or maybe his way of expression that they can either do the flowchart or then write it out in natural language which … it could be a preference … you can give them the opportunity to choose between the two, umm, and there might

be somebody that is most comfortable with doing the flowchart and then writing it out so before he gets to the expert system then he knows that there is nothing in-between that I left out.

I: OK, anybody else?

R6: Following on what I said earlier, if you could do a video clip and have them discuss a concept, like *purpose* for example, and then once you have summarised and told them this is what *purpose* is about and then move directly onto flowcharting purpose, then it keeps everything together and it actually gives them a good understanding of what it is when you talk about a flowchart; what it is that you are trying to achieve with them. So I think what you did there was quite a good way of doing that.

I: What was the word you used earlier?

R6: Contiguity, that means touching.

I: Did my representing the understanding directly in a flowchart work for you?

R4: I think it worked well and then again moving into them modelling their own diagram based on their own scenario, like last week's exercise perhaps. It would work well after you have done that example. And they are still not going to model what you have done there; they will still have to think about it themselves. It will work.

R5: I think that it links nicely, theory with practice, the flowchart. Because now they did the theory, all these concepts and now they must just represent it practically in an expert system, and, umm, I think this provides a good link between the theory and the practice.

I: So it worked the way I did it there?

R5: Yes, yes.

I: Anyone got anything else to add?

R2: I don't know what they said but the visual clips were very interesting, that's always interesting to students to have something like that and not everything paper-based. So I think that will be a good starting point or point of departure for the students. I don't think it was difficult, we used some terminology that we know but I think the students will be able to, mm, describe what they know or the situations or their ideas.

I: Anyone got anything else to say?

R6: Umm, perhaps consider when you do this paper-based exercise, to do a clip and then make them answer the questions on it, do a clip and make them answer the questions on it because it keeps the content of the video fresh in their minds as well while they are busy do that. Umm, make sure that in the room where you are playing the videos that the students can actually hear what the guys are saying in the video clips. Because when I looked at the video clips I could kind of hear a voice and I could hear that they were speaking but I couldn't actually hear the voice and that's because of the sound quality in the room. It's not the sound quality of the clip; it's the sound quality of the room. So for this to really isolate that which they are supposed to see they need to be able to hear as well as if they were sitting in front of a screen. They need to have that kind of perception of what's going on on the screen. So just make sure about that. OK, I mentioned that with product, when I read about product I know what product is but there is a bit of ambiguity in the way in which they describe

it. They say the product is the physical, kind of thing on which the message is conveyed in the end. And if you say the message is the paper or the blackboard or whatever and you refer … and you say the product is the paper and you show them the paper like that, they are going to think that the product is the naked paper whereas the product is really that side of the paper. You see what I mean, the product is really the whole thing with the words on it and the right font and the tone of voice and everything. That is the product, so you must just make sure that they understand that when you talk about the product you are not talking about the medium, you are talking about the whole kind of physical representation of everything. Umm, and I need to still think about the flowcharting thing and weather that in the end … I'm looking at … that's why asked you to mention your research problem again because your research problem is not really related to the CMAPP concept, its related to, umm, to the internal construction of a concept so, umm, I'm looking at it from a different point of view, I'm thinking what's going to happen, what's going to work for the students to understand CMAPP in the classroom which is kind of what you need to do in the classroom but for the purpose of your study that's not what you are trying … that's not the focus of your study. Umm, so for the purposes of your study I think the flowchart will probably work. For the purpose of them understanding the concept it might not be the best way for them to understanding the concept. So that's why I say the flowchart might obscure their understanding but then again I've got my lecturer hat on and thinking about what's going to make the students understand best. So I need to get my head around your research problem still and the flowcharting and the construction of the intelligent system. I need to think about that still.

I: Actually I don't think that my research problem and the instructional aim of the lesson are in conflict with each other.

R6: It will work; I'm just saying that I don't know whether it is the best way.

I: What would be a better way?

R6: That's what I'm saying, I need to think. I will. I Promise, I will.

I: Maybe once we have worked through the whole process you will have a clearer understanding of what you want to do.

R6: Ja, ja.

I: Anything else? OK, thanks very much.

Transcript of focus group interview held on 18 February 2011

I: Impressions of what we have been up to today?

R6: Umm, nice I think the way of getting to the logical way of flowcharting something like context … It was a nifty idea to do it this way round, I think it might work well, … umm.

I: Before you carry on, why do you say so?

R6: Because what you are doing is you are going through the thought process that they need to follow to get to the questions that they need to ask to get to the flowchart without them knowing that that's what they are busy doing. And so in the end when you get to … that might become apparent to them what you are busy doing but, umm, it's going to kind of help them to understand … without asking them to give me this and this and this you guide them through a process which is the process that they need to follow to get this and this and this. So they actually get some practice at

doing that without them knowing … without them being intimidated by this vague question that you are putting to them … so, yes, it's a good way of concretising, umm, the process that you want from them. So yes, I think this worked well, this approach. Ah the one … A couple of things that I made notes on, the one thing, when you show them skits, umm, perhaps you should think about whether you want to use humorous skits or not. Because what happens, you've got dual signalling, if I can call it that, in a humorous skit. So this is … L\like a serious thing going on there, there's a business meeting, which is serious but you've got subtexts because of the humorous nature of the skit that you are doing which is perhaps confusing when determining the tone ... you know. For us that was difficult when we had to ask you the questions because … umm, and also I think for you to answer those questions because it's a meeting but it's also funny... you know … how do you answer that question. So perhaps you should take something like the rock concert or the interview where there is just kind of … there's no subtext in the video. Perhaps just think about that. Umm, the other one I was going to give you some homework. To do this in natural language and see what you can come up with. And then, let me say this for the record. Your facilitators need to be trained for constructivist interaction. That's not something that comes naturally. A story that I want to tell, when we worked with Johannes, that's one of the stories he told us is that he went to a school to try and get them to start working constructivistly, umm, and he said that the first thing that he needed to do was to actually train the facilitators how to facilitate a constructivist learning environment. That's not something that they learn naturally. Naturally you want to stand here and you want to lecture down to people. So you need to get used to this constructivist environment where the learning belongs to you constructors not to your facilitator. And when you have a dead spot you need to trust that dead spot, you need to know that that's part of the process you know and how to facilitate through that perhaps. But, umm, if these guys aren't trained and they walk in there and

they encounter a dead spot the natural reaction is to start lecturing, umm, so they need to rained on how to facilitate in that kind of environment. I know that we walk into a classroom and we say this is the year that we are going to do it right and you give them homework and you say *Go and read this* and you come back to class and you just ask them a question; you ask them the first question and nobody answers you and you wait for a while and there is this unnatural pause and then you start talking and there you have lost the plot. That's something that they need to learn how to do and once that happens … that's just the first. Now you've got a group of learners who've never really worked in that way, so they need to become familiar with a constructivist learning environment, they need to overcome their natural resistance to speaking up in a group and to participate because you can't construct knowledge, especially in a social constructivist paradigm, you can't derive group meaning if nobody is speaking. So you need to do some training beforehand before this is going to work, I think.

I: Thanks.

R3: Umm OK, I think the … again, as with the previous session, the interaction that you facilitated worked very well, umm, the clips that you showed, on a level of interest to the students, would I think involve the students very well. I think it worked extremely well, but I want to agree with what R6 said, the facilitators in class will have to be very invested in this and you will have to train them. Umm, and then I think you bridged the gap very well today, jumping from the conceptual learning to physical manifestation in the flowchart. For me today there wasn't that moment of hesitation of what should I do next, it flowed naturally and that worked well.

I: Just the same question that I asked R6 just now, why did it work well?

R3: Umm, I think it was a natural progression into … because you have already now drafted the questions and you don't have to now go sit and think, if I do this flowchart now what would be the best question to ask, what would … to develop questions, because now the questions are there already and, umm, just one more thing, I think using the newspapers, using the clips, the real-life environment, I think that worked very well. It's not something separated from what they do every day, they see that this is real life, this is how it is and they can work through this. It's not a separate concept that they have to grasp.

I: OK, thank you.

R2: I also agree with what R6 and R3 said. For a while I thought when it came to the questions that we should go to the who, what, where, why but that's just and how I want to teach the students. But that's not what we, what you want to do. Its best to let them come up with questions and then, maybe from that they can see, OK, if I ask this question then I can answer, you know, who is involved is actually the relationship, which can encompass many things. But I think maybe for students to make it more basic is to have specific questions, like, what is the relationship? And what is the setting? To make it more concrete, yes for them to learn. I also agree with them about the facilitators and maybe your first class or the first thing, when they introduce it you should maybe be there just to check that they know what is going on and they are doing what they are supposed to do. Otherwise you are going to, umm, leave it all in their hands and then in the end maybe get some feedback or information that this is not quite what you were hoping for, I think.

I: How do I … The idea behind today was to bridge the gap between a conceptual understanding and a representation of that understanding. How do I improve this?

R2: It was natural for me … when you had the questions … remember they have seen all of this … asking the questions and they know what those shapes mean now so now when you put the question there then obviously they have to think of all the different settings; for example, and then take one and what's involved there, that is logical to me. It's logical also because we have that background and you have done that in the beginning, showing how this chart works, that was good. If you haven't done that and you get this now then I would have been lost.

I: So you don't see any obvious room for improvement at this stage?

R3: For me it was actually, I must say, in one of the previous sessions, where we had to make that jump, I had to readjust my mind and OK, now we are going to the flowchart, what now. What question is first? What should happen now? And with the questions already developed today, you could basically just apply it to the flowchart and there were not so many things that you had to consider so that it wasn't as daunting a task. There were things that you had to think about but because you already had those questions it just made that gap more digestible and easier to work with.

I: OK, thanks.

R6: I think that when you start drawing you flowchart, your question to us was, "Which question would you ask first?" But because there is not real correct place to start at, perhaps you should say, with which question do you want to start? Because that, umm, will tell them that the order of the questions … now this is difficult because as you said sometimes some questions do lead on to the other, umm, but unless that is like really, really apparent from the questions that you would need to ask this question first. If there are five questions and they are all equally

important, it doesn't really matter where you start; I would ask them, "Where do you want to start from?" so that they understand that they can start from any place and the way in which they do it is not going to be incorrect if you start doing it at a different place. Umm, so that thing about that there are many different ways of representing that because your learners … especially if they are like younger learners they are going to want to copy what you are doing. So if you don't make that very clear you are going to see all of your flowcharts looking like this and you … I don't have to tell you that. Umm, the other thing that I think you … that we can do to … starting from here is really where the learning is going to start taking place, when we send them back in their groups to go and develop a flowchart on their own. Umm, because that's where they are going to start negotiating amongst themselves to get a flowchart on the ground. So I think that's really where the understanding is going to start, when they start interacting with each other and in that process I think the first couple of times, you as facilitator, are actually going to learn a lot about how to facilitate this kind of thing. Because once you get the first representations back you are going to start understanding how you students understand stuff. So that will tell you what they are doing right and what, in inverted commas, what they are doing wrong, in inverted commas. And umm, so then you will be able to tell them, this thing that you are doing here just think about it this way. So your facilitation is also going to be responsive to what they come up with. But I think that it is important to, from here on, to take that to give it to groups to do some work on their own, to really get to grips with what this process is. I think what happens in our little small group is we always kind of … we don't have time to sit down and really work out what it is that we need to do and that's part of the problem why we don't really get to grips with what I want. But if you go away and you know that by Tuesday you have to come up with something, we are going to actually negotiate a common understanding. That will aid the learning process I think.

I: Anything else? Thanks again.

Transcript of focus group interview held on 23 February 2011

R6: One quick observation is that the nice thing about building an expert system like that is that it is quite easy to assess, I don't know whether that is the right word, to assess whether their logic is valid. Because if you look at the screen when you do the screen preview kind of thing, they have got two conditions selected and they have got a display and if those things match up logically it means everything else must be in place. It doesn't matter how they got to the answer; you are just interested that they get to a valid answer. So what you can do is to go around and have a look at everybody's, you know, thingy, what they selected and what the display is and you know whether they have done it right or not. So it is a nice way of …. Remember we spoke about you having a jig and you take something and you put it in a jig and if it fits then it works, so this is kind of a jig for their understanding. If that works then their internal representation … .You don't necessarily know what the representation is but you know it's valid because it comes up with the "right answer ".

R1: OK, what I liked about this is the approach that we worked together as a group and that we kind of reminded each other and that we learnt from each other. So it was kind of a socio-constructivist approach here. And I think even if we have different learning styles and ways of remembering, it worked because we had these visuals we had the auditory, we had the interaction and to create and expert system like that is a challenge but working together, it works.

I: Good, thanks.

R4: To build on that, so maybe we should think about are they going work in pairs in small groups physically in the labs, that's something we should think about, because it worked well now when we worked in a group together. And I was also thinking, in a lab, will the students also be able to see what you do on the computer on their own computers or will there be one overhead, because that's not going to be practical, in those huge labs.

R1: It will be in steps, the first one everybody does together with the lecturer so they see it on the screen like we did now; the second time you can make groups.

R6: I don't know whether you have NetOp in there, the facilitator can control the screen of the students. So you can physically take control of the screen and show them what you see on their screens.

R4: We are going to need that, do we have that?

R6: They ... it used to be installed in the labs at Sosh.

I: But guys, what I am proposing is actually presenting exactly what we did now to the students; they are not in groups yet, it is as a class. Once we have got a flow diagram representing their groups understanding of context, I want to do exactly what we did now. In other words, let's develop the expert system as a class and invite volunteers from the class to come and do it while the audience shouts instruction, support, and guidance to those persons. Your impressions of that?

R6: This works better if you get the class to do something. It's like if you drive in a car to a certain destination, if you are the guy driving you get to know the rout to that destination; if you are not driving, you are just a passenger, you get to know more or less where it is but you don't know the road. And

it's the same kind of thing here. I found that when I was looking I kind of had an idea but as soon as you sit and do something yourself then you get the proper idea.

I: Is this step necessary? What I did now, is it necessary? Because remember, they are going to get a lot of practice doing it on their own. It's just that I need to give them a little bit of scaffolding.

R6: For us today I think that it was necessary because we hadn't done it for a while and then we didn't really know what we were doing. So in today's groups it was necessary.

I: And for the students?

R6: For students if they did the previous step, remember when we learnt the software, if they had mastered it then, today might not have been that necessary and you will be able to pick this up when you start doing this and the students can immediately tell you what to do next; then you will know that they are on the same page, if they are not ….

R4: I think that this step is going to be crucial, because time is going to be a problem.

I: My thinking behind this is for it to be some sort of consolidation exercise. Because remember, we have talked them through the process of asking questions to gain a conceptual understanding, taking that conceptual understanding, representing it using a flow-diagram and then the consolidation will be actually, the group … because remember, we have all worked in a group up till this point, actually developing the expert system. Is it necessary?

R6: Its not difficult stuff, so if they had gone through the software earlier by this stage, if we get together as a group and do this consolidation stage, umm its going to refresh their memories pretty soon if they have forgotten some stuff. So I think if their prior knowledge is adequate; then, at this stage you won't have to work individually again like we did today. Unfortunately the only time that you are going to know whether they know enough is when you start doing this. Because if you start doing this and you don't get answers or you get the wrong kind of answers, then you will know that they don't have the prior knowledge that you assume.

R1: If they haven't had the opportunity to work on this then, umm, they might not really have that pre-knowledge. This step that we did today is the first time that we, that each one of us had the opportunity to sit and work on it. So they might have an idea but to really do it as you were saying ….

R6: Yes, we did work on this earlier, I don't know if you were here that day. But there is an assumption that during that previous phase when they learnt the software that they actually will learn the software, so at that stage they will have to work on a kind of individual basis.

I: OK, can I just round this off? Is this a good way to consolidate the learning at this point? Yes or no?

R6: Yes, I think so.

R1: Yes.

R5: Yes.

Second focus group session

I: We have got to the point now where we have to present the students with an ill structured problem, because that after all, is the point to this whole thing is that they can represent their understanding of a concept by developing an expert system. How do we present the ill structured problem to the students?

R5: I think by giving them a scenario because that will be … the problem will be situated within a real life scenario and it will give them a little bit of information or structure. Although it's going to be ill-defined it will give them a little bit of structure just to provide scaffolding for them to start with their designing the expert system. So I think scenario, they must be presented with a scenario.

I: OK. Any ideas on the nature of that scenario?

R5: I think like we usually do in tests, in the form of a written paragraph, in written form.

R1: Maybe a problem.

R4: Or perhaps a video again, like we were doing, the communication scenario.

I: All right. How would the video represent a problem that they would need to solve?

R4: Well, they would need to … Yes; I see what you are saying so you have to think about the communication in that scenario but ….

R5: Maybe a scenario on a video that illustrates a conflict situation that's a problem that they would have to solve, a conflict situation in an office environment for instance.

R6: I think scenario I think is good; it can be millions of different scenarios so pick one. I think that when you describe your scenario you must have five components kind of covered in the scenario and the il-definedness of the scenario depends on how much information you give to them when you describe the scenario. So you can describe that scenario in the greatest of detail and everybody will come up with the same kind of answer. But if you leave some information out … the more information you leave out the more ill defined your problem becomes. Umm, and then finally, what I would want them to do, after they have done the intelligent system that is play stuff, they must actually turn that into a product and you assess the product for whether it's covering the five components. Because if you see the five components that they render, that's where you are going to see whether they get the whole thing. Umm, in terms of what do you do with the ill definedness, how do you get a clarification of the blur, that's where I was talking about perhaps having a boss and a secretary or a .. Where a boss gives a scenario to a secretary and she has got to come up with, ultimately, with a letter that she writes to a troubled customer or something like that. So ultimately the output of the whole exercise is the letter that the secretary is going to write and she writes something and if there is information that she needs for her to write the letter she has got to refer back to the boss to get more clarification about that. Umm so yes, I think that kind of scenario where you have customer client superior subordinate kind of thing, where somebody gives a problem to somebody else but this … the amount of information that you have in that instruction is limited depending on how vaguely you want to define your problem and then you tell your student, your secretary that if there is anything that she needs more, to know more, she must come and ask you direct questions and you

will answer direct questions umm, so in that context maybe you should have yourself as the boss and groups of students as secretaries.

I: What do you guys feel about that, bearing in mind that the aim is to get them to develop and expert system not necessarily to get them to write a letter or produce some sort of product? So my feeling is that the scenario should lead to the production of an expert system not necessarily a letter, so the scenario would have to be something along the lines of "You work in a company that has communication problems. Develop an expert system that would guide them to become better communicators." That is the sort of scenario I had in mind. What do you guys feel about that?

R5: If you ill define it like that … maybe just to show them a video or two in which they can get more information. For instance, you have communication problems within the company but then, for instance, you show them two scenarios in the video what happens in a meeting and what happens when they are working in an office environment because I think that they will get a lot of hints from that in order to help them construct their expert system. So, in writing ill defined but when showing them the videos showing them or giving them more information that they can use. Not clear cut information; they must still look for it so it's still ill defined but they must look for it in the video, read between the lines so to speak.

I: Anything else?

R6: I'm thinking, if you select the correct video, let's say for example you've got a video of a board meeting and ultimately the kind of product that you want out of that is a set of minutes, let's say for argument's sake, then you tell your students OK, here is a board meeting; go and write the minutes of it, develop an expert system that would help you write the minutes for the

board meeting. So then they look at the video and they can look at it over and over and over; that becomes your source of reference for information. The problem is ill defined. If they need more information they can go back to the video as many times as they want and get more information from that and then ultimately they can develop their expert system based on their understanding of what happened at that meeting. And I'm saying a meeting, you can use something else, it's just the first thing that came to mind.

R4: I like the idea, just looking at the scenario and thinking your expert system in the end could tell you how communication could have been done better. That's your main goal. Does that make sense? So maybe that can be your approach and even though again before starting with the actual exercise brainstorm in what way in that specific scenario could communication have been done better. How can you improve communication in that specific scenario, and that's something; that can be a starting point of the expert system.

R1: I agree with him because I think brainstorming is a very good part. I'm back with a socio constructivist approach. If you would have one scenario, say a video clip and then discuss it in say a brainstorming session and say, what the options could be out of this. How can we create an expert system out of this situation? Discuss it with each other and learn from each other and the next one they have to do themselves.

R5: Almost like a test run.

R1: Yes, but as a group, learn from each other and then ….

I: What do you guys feel about that?

R4: What you can also do is use the same scenario and then they on their own from that point onwards.

I: What role does the facilitator play in this whole process?

R5: Provides the scenarios, but how far should he be involved? But that's why think that it should also be put in writing; the problem statement should be put in writing and as a support you show a video. Maybe … I think … it mustn't be taught or lectured, it must be in the background, and the lecturer must be in the background. So I think scaffolding must be supported by the written instructions and by the video.

R6: I think that the right word is to scaffold the learning, so if they ask you a question you ask them a question back, so you don't want to give them direct answers to questions kind of thing but you want to guide them in the right direction. So you don't want to be directive but you want to elicit thought; so if they ask you a question you don't tell them to go and do it like this, you tell them about different things that they should consider for themselves, so it's a provider of scaffolding not a … .

R4: And just to make sure that they have covered all the elements in the communication process and that they have only focused on the setting, for example.

I: How? How do the facilitators make sure …?

R4: Well, let's say for example, in the brainstorming session by asking ... let's say … not talking about barriers ... they didn't cover that ... by asking questions, like triggering their minds.

I: Remember, we have moved passed the brainstorming; they are actually developing their expert systems. What role must the facilitator now now?

R1: He would be like a resource, so if they would get stuck they would ask him questions but he doesn't hover around them and check that they are doing it correctly, so they go to him if there is something that they are not quite sure about, kind of supporting them if they need him.

R6: The thing that I hear you say often and that you must be careful about, you say that when you do constructivism that there is no right answer and that's actually only partly true. So if you want them to have a conceptual understanding of CMAPP the elements that they come up with in their intelligent system have to vaguely resemble those five components of CMAPP and so when you facilitate you have to make sure that they have got something in their model that says *contex*t; they can use another word for it, that's fine but they must have something that says *context* and they must have something that says *product* and they must have something that says *audience* or what ever the case may be, umm, because if you don't do that … if you don't make sure that that happens, they can come up with a model that is kind of a incomplete model and in our environment we have a responsibility to actually convey, umm, a proper model. So, it's good enough to say whatever they understand is valid but not in our environment; in our environment there are certain outcomes that need to be achieved. So you need to make sure exactly what the outcomes are that you want from this exercise.

I: Should that not be implied in the ill structured problem? The outcome should be implied in the ill structured problem?

R6: The information and stuff should be given in it, it's just that you have got to make sure that they pick it up; they might not pick up that ….

I: OK, so it is the facilitator's role to ensure that the ill structured problem is adhered to? Or solved?

R6: But they get all the information from the ill structured problem that they need to get from it, so you need to guide them in that direction.

R4: I don't know whether it's too much information but maybe after one or two weeks when they have been working on their expert systems to make a list and ask whether they have considered these elements in your expert system. I don't know whether it's too much information.

I: So just do an interim development meeting or assessment?

R6: And then if you see there are some shortcomings you do you're …, what about this, what about this question; move them in the right direction.

I: And how do we divide them into groups? How do I tackle this issue?

R4: It usually happens naturally, in pairs or we must decide now will it be pairs or groups of three or four but usually that's not a problem.

R1: Doesn't it depend on how many computers you have? Umm, how many can work on one computer? If you want to develop and expert system you need a computer, so ….

R4: It would be impractical having four people sitting ….

I: What I am really asking is, do we combine different expertise levels? If so, how?

R6: I like having balanced groups, because if you don't have balanced groups in terms of mixed capabilities kind of thing you get kind of a skewedness in the learning that takes place. So perhaps what you can do, just as a suggestion for every group you define four roles. So there is a scribe and there is a whatever. So what you can do is, depending on the capabilities in the class, lets say if you got … I don't know if you want to use previous test scores or something like that, stratify your class into four strata and then the bottom quarter you make them all scribes and the second quarter you make them … umm … tea carriers, whatever the roles are that you want to define. And then what you do is, you say OK, we have got twenty groups that are going to do this, you can select in what group you want to be but there has got to be a scribe and this and a this … in every group. So they can select in a way, which gives the freedom of choice which is a nice adult learning principle. They get some choice, but you have a mix of some talent, ability or whatever in the different groups. So there is some degree of free choice as to what group they belong to but because of the way that you stratified you roles within the groups you are going to get a fair spread of ability within the different groups. It doesn't have to be on the basis of previous scores; it can be on the basis of, I don't know looks.

I: What about on the basis of self-assessment? How would you rate your understanding of CourLab? And then say those that scored one over there, those that scored two over there, those that scored three over there, self-assessment, divide them like that?

R4: And you put all the ones and the fours together, something like that?

I: That sort of thing, combine different levels of ability determined by their own assessment. Something to think about.

R6: Sorry, I've got problems more than answers. The problem with self-assessment, you need to standardise the self-assessment because what is excellent for one person is very poor for another person.

I: The reason why I said that was because, even in this small group, here we had people like R2 for example who lacks confidence completely and she would rate herself right at the bottom and then we have got people like yourself who have a good grasp of this and I think that self-assessment would be very accurate, so its maybe worth a try.

R6: It's difficult because if I have to rate myself according to other members of the group; that's one thing. If I have to rate myself according to the software I'm going to rate myself low. That's the problem with that, because normally the guy who knows a lot knows how little he knows so you down rate yourself and the person who doesn't know a lot knows everything that he knows. You get kind of that skewedness in self-assessment often, so if you don't standardise it you get funny things coming out.

I: But do you think that it's worth a look?

R6: You can explore it, ja.

I: All right, how do we get them to compare and contrast their understanding? Remember, we have divided them into groups now, now to compare and contrast, any ideas in this regard?

R1: After they have constructed their expert system, they will be presenting it to the class … are you talking about different groups now that are contrasting each other?

I: What I'm trying to get at is how do they show each other what they have done?

R1: I think that it would be good to present to the others what they have done and explain what their thinking was.

I: OK, any other ideas?

R6: We used to do home groups and specialised groups, so you get … you get two sets of groups. So to every specialist group you give one component to go and explore and then you reconstitute. So they work in different groups on the components and then they come into the home groups and hey share their understanding and in that way you do have that where ….

R1: Would that not be a very long process? I know what you are talking about, I've tried that, I've done that but it takes very long. It's a process where each one of them becomes experts, they have worked out their expert system, their way of thinking, now all of those have to move into other groups, so it's this whole process where you have got these other groups on the side and it's say in the middle. So it takes ….

I: I understand what you are saying about the specialist groups, but what concerns me is that the integrated nature of communication will be lost at some point when we segment it too distinctly. How about this for an idea? What, if after a period of development, I combine groups and they take the best of each and they come up with one. What do you all think of this concept?

R6: You know, like at conferences and work sessions when you do like breakaway groups and people come back and they do report backs. So if

you have your different groups go and construct models, come back and report back to the bigger group, but then importantly, they have to go back to their groups and redefine their understanding. Because otherwise you never concretise that the compare and contrast thing does not concretise unless they go back and look at their models and see what they have learnt in the bigger group effects what their understanding is.

I: How do you all feel about that?

R5: Refining the problem.

R6: Perhaps an easier way of doing it rather than a home group specialist group thing because the numbers in the class will affect how the groups work.

I: And also one of the concepts that they need to understand when it comes to CMAPP is that the elements cannot stand alone. All right, my last question is, “How do we evaluate what they have done? What process can we put in place that would allow us to assess, monitor, and evaluate what they have done?”

R6: That’s why I came up with the idea that after they have developed the expert system that they actually have to produce the product and you asses the product because that product is going to give you the best representation of their internal model.

R1: The problem with that is that there might be steps ahead of this that they did manage, so if you look at only the end product and you say that the end product is now … a hundred percent … how can I assess that you just maybe assessed one of the components to get to the end product and he

gets zero out of ten. I think that there needs to be a rubric that comes from the beginning through till the end certain sections, they are either competent or incompetent.

R5: Continuous evaluation.

R1: Yes.

I: My concern regarding that is them being able to produce the perfect minutes of a meeting or the perfect letter does not indicate that they have a conceptual understanding of the model; it just means that they have some understanding of what a good presentation should look like, or a good letter should look like. It doesn't really say to me that they have considered all the elements involved in the process.

R6: Does it matter?

I: I feel it does, because they may have got that information, they may have arrived at those templates from some other source. What about if we get the different groups to evaluate each other? What model can we develop in that regard? You know, based on the ill structured problem, have they arrived at a decent solution? I know that our agenda is to get them to write the perfect letter or to present the perfect presentation but I think that that is thinking very narrowly, I think that it is a conceptual understanding that we are trying to achieve here. So I think if we get them to assess each other's models or each other's expert system in relation to the ill structured problem that we presented to them. What are your thoughts in this regard?

R6: Umm, I think it is important ahead of time to give them an assessment rubric, to tell them what it is that you are looking for and if you make the

group self-assess or peer assess … as long as they assess in terms of your initial rubric. And perhaps you want to calibrate that just a little bit to make sure that they don't just give everybody a hundred percent kind of thing.

R5: What about if we let the group just write a test at the end of all this?

R1: I think that more leaning takes place when interactivity takes place and discussion takes place.

I: Well, what about getting the separate groups to use each other's expert system after you present them with a problem and you have to adhere to the advice of the expert system? In other words, you present them with a situation and you say, "I want you to use the expert system to guide you toward a solution". They use the expert system and they produce a product. What do you guys feel about this?

R1: It's kind of the same as presenting it?

I: It's kind of more experiential, they are experiencing it.

R6: My feeling about that is that it is just about as authentic as you can get it if you want to go the way of having an expert system developed to let somebody who doesn't know the expert system use the expert system because that's what expert systems are for, to get people who weren't involved in the development of the expert system.

I: So you like the idea?

R6: I actually like the idea, its more authentic than using you own expert system because you can read stuff into your own expert system but

somebody else doesn't know the assumptions that you built into your expert system so that way round they use the expert system and they use the display stuff to come up with the product. That's what I always say, if you use the display section to come up with the product and you l look at what's in that product and what's not in that product it should give you a clear understanding of what went into the thought process.

I: Would it be a good idea to get the group to critique the expert system?

R6: I like something that R1 said earlier; you get the group to critique the expert system and then they get the opportunity to go back and fix whatever didn't work well. But this takes time. That is my big concern with what we are doing here is that it all takes time.

Transcript of focus group interview held on 25 February 2011

I: Your impressions of the way the ill structured problem was presented and constructed?

R2: I think that it was good. In the beginning it was difficult for me to comprehend, not comprehend but as you said, we always have the problem in mind and then you actually know what the solutions should be and the students should arrive at. So that's why we asked you for your papers so that we can see again what the problem was and then from t hen on we decided, OK, this is the problem and those are the things that we have to look at when we … the context, the message and the audience, if we want to do the flow-diagram, the design and arrive at an answer in the end. So, yes, its long, but I think that it has all the background and the information and it's not obvious what they should do. They will have to think and that's why R3 and I sat for a while and decided what it is that we will have to do.

I: So you think it is an improvement on the scenario Idea, a straightforward scenario?

R2: Yes, because it is not straightforward. You have to go through that and decide …you have to in the group decide what the actual problem here is. You have to see what the problem is before you can carry on and develop this.

I: And those dilemmas are good?

R2: Yes.

R3: OK, I think that the way that you presented it, if I can use R6's word, a brief is much more, umm, open in terms of not limiting the students to a specific scenario and its much less prescriptive and the fact that it is on paper so that you can go back to and refer to it again. Because as we went along we wanted to go back and consult it again because you build on your own understanding of its levels.

R6: Umm, I think we are probably moving in the right direction by having a very broad, almost undefined introduction. And then scaffolding your way toward a more defined problem setting, more defined definition of what the outcome is. I think that's a good way of doing it. Just a general comment, if hand out the homework assignment ahead of class that means you are directing what happens during class because they know that they will have to find answers to these questions. What will happen then is that they will use the interactions to answer those questions which are not the constructivist way. If you hand out the instructions at the end of the class, they don't have the resource of group discussion ahead of them to get the answers, so what they will have to do, they will have to consult their

mental model of what occurred during the course of the event to answer the question so probably that is the more constructivist way of doing it. Just for the record, if you want to give them and assignment ahead of time to write a letter and one at the end of your interaction here, to write the same letter so that you can have a pre- and post assessment to see … it might make the learning overt to the learners. They might see the value of having done it this way.

R5: The open problem that you gave them fits nicely into your constructivist approach. Because it's open-ended and it's ill defined so I think it's a very well constructed open-ended problem that fits nicely into your premise of constructivism.

I: And how did you guys experience starting the development of the expert system?

R3: With everything that we have gone through and with all the scaffolding that we have had up to now it was actually not a daunting task, we had everything; now we just had to consolidate and put it all together. R2 and I enjoyed working on a flowchart. Just sorting out the questions first and then just to get a mental picture on paper and with all the layers what that mean. The flowchart proved to us that if we express it this way that it would be a logical next step. It actually led us in the direction of getting to something that would be able to answer different questions regarding different things.

R6: I think, umm, the fact that we did what we did last week was tremendously helpful in terms of what we did this week, in terms of having sat in front of the computer and actually design stuff. What happened was that that was just in time; it was just at the right moment that you did that. The learning was easy then because you weren't trying to learn software using some

abstract scenario to build something. You were learning functionally, you know that this is what you need to do and you are going to use software and now we are using the software to try and achieve something specifically. So it makes the learning easier because you have got in mind what you want to get out of the system and now you are learning how to do that quickly, it was just the right moment. That made today's exercise much easier because now I could actually sit down and use your software to do my mental representation.

I: How is this influencing your conceptual understanding of what we are up to? I know that you are not necessarily novices but by plotting these things and developing these things you are changing the way that you are seeing it. Are you seeing that are you experiencing that yet?

R6: I'm seeing that a bit already. The comment that I made in the group now now, you need to ask a question, have selections and that's got to influence what's going to get printed at the bottom, tells you how scenarios and stuff like that are ultimately going to affect your product. And I think that's exactly the sort of understanding that you are trying to get, that different things will influence your final product. So I'm already getting a sense that as you go along you are going to get a greater sense of that but I'm already starting to get that kind of sense.

R3: I just want to add to that that I think the fact that the facilitators should be available to provide scaffolding is extremely important. The students shouldn't start working and then be left floundering.

I: What sort of scaffolding was useful to you?

R3: The fact that you were on hand, we could ask you something, it didn't slow down the whole process, we could ask you quick questions, we move on. It's not something we have got to ponder and sit and try and work out.

R6: You need to establish that the students must ask questions when they want to ask questions. Because what the question does is it gives you an indication of their understanding, and you can't really scaffold appropriately unless you know what they know, and the way in which you know what they know is they ask a question and as soon as they ask you a question you know what they are thinking and then you can scaffold appropriately. So that is very important that they will have the freedom to get up in class and ask you the question.

R3: Can I just add one thing so that the thought does not get lost. If you can have a big representation of the flowchart symbols, so that everyone does not have to go back to a handout every time it will speed up the process, I think.

I: Anything else? OK. Thanks very much.

Transcript of focus group interview held on 2 March 2011

I: Thanks very much everyone. Can I just get your general impressions of what we been have up to today?

R3: OK, what we did today I found very useful because the previous times R2 and I did a flowchart and the actual, I don't know what to call it, the coding, it showed us the faulty logic in certain instances. It helped us to develop in the IF THEN of an expert system, so we had to go back to the underlying rules and make sure that those were in place. So that made it very practical for me and that I found good. The discussion, the five minute discussion that you had with us in the beginning to show what we are going to do, the outline with the students I think that works well. My only

concern is time but I know that it is difficult to predict ahead of the event what the time issue would be.

I: Just before you go, what did you struggle with today?

R3: I struggled with the fact that we did the coding …you taught us the coding that we will have to use about two or three weeks prior to today and suddenly I had to make that shift again and it was there vaguely but I struggled just to get that in place and that took time, to understand how to do the coding again using the program.

I: So if you had to do this immediately after you had practised this the first time around. Do you think that problem would have still been there?

R3: I think that it would have been much less of a problem.

I: Thank you.

R2: I made notes the last time that you showed us to do the IF and the THEN and the questions etc., and now my notes two weeks along the line do not always make sense to me as it did at that stage. So I agree with R3 if following period if I had used that and done that then I would have remembered and also if I do it myself then I would have seen OK this is how it works or this is a problem, called you, you showed me. I was out for a little while when I came back I was lost. I didn't know where to go for IF THEN, you know where to go for IF THEN. When he told me how the logic works I understood that and then you have to go back there and you have to do it yourself so what she did but if I don't do it myself and look at my notes and then go back and see OK, this is actually what happens then I am going to struggle, and that is why I struggled. Struggled with why do I have to hide, but I understood that in the end. Because it becomes an IF

THEN, if this then otherwise if you see that then it doesn't work. So I get that. My problem just now is that I don't know where to put in the IF statement, I understand that I have to do that and then it's going to show there. And another thing, if it doesn't work I don't know where to go back and look for the problem to correct the problem. If you talk about it makes sense and on paper … But then I don't know where to find that. I can't remember.

I: Besides the immediacy thing, besides the time thing, what would help you?

R2: Umm ja, I have to do it myself. I saw what R3 did for me because I'm not used to this and I'm right brained totally, for me what would help is if we did it immediately afterwards and I had notes and facilitator on hand and I could do it, try it myself, and if I make a mistake I ask you and then rectify. That's the short term memory, medium term memory, then I will remember. And then the next period I will have to do it again otherwise if time lapses, gone out of my head.

R5: I think that doing it for yourself is the best way because if you make mistakes you learn from your mistakes because you have to do it over and over because you have to get it right. Even if you … because we made a mistake with our coding and we also had to re-visit our logic but not only the logic of the programming language but also the logic of our CMAPP structure to see whether our option did make sense. So I think it's absolutely higher-order thinking because if you are solving problems the whole time, regarding your logic in the programming side but also the logic in the CMAPP, the communication theory side.

R4: And what I would also recommend to the students is that there's not only one person doing the typing because when I was following what R5 was

doing sometimes you lose his line of thought but as soon as I started doing the second one on my own then it really settled in my mind.

I: I think that that is naturally how it is going to take place in the class. How are we going to overcome that?

R4: But usually there will be one strong person in the group that will do everything; we must try to avoid that.

I: How do we avoid that?

R4: Every second action a different person must do or something like that. But it's something to think about.

R6: Umm, two comments. I think importantly, the thing that I saw about R2 when she came back is that as soon as you lose track of what is happening on the screen you disengage. You could physically see that. And that's a problem … let's say for example that she is driving and she becomes quite good and R2 is not following yet, now R3 is going to fast for her to follow; then you are going to get that so we need to think of a way in which you can go through a progression where perhaps R3 does one or two but eventually the focus needs to go where everybody does stuff for themselves or they take turns. But I don't know whether the exercise is bigger enough for everybody to take turns and have enough exercise to actually build up. So maybe they will have to go and build their own one individually in some or other way. The other thing that I noticed now about the discussion is that everybody is talking about the software; nobody is talking about a conceptual understanding of the model. So that is not happening at this stage; higher order thinking about what the model looks like, is not happening.

I: I think it is.

R6: You know what, at this stage not yet; it will at that stage where you guys are probably. Because what happens is, you are starting to see Ok if I select this and I select this and I select this then I get this answer. Now you guys are starting getting there. Remember last week I made the comment, I was kind of unclear about this expert system thing until I started seeing that if I select this and I select that and I select that, what the response is at the bottom and then what I got here … remember what we did was to say the setting is informal and the subordinate and then our display was that the setting was formal and the subordinate, which is not an expert system it's just an aggregation of what your selections were at the top so we then understood that the question needs to be different and that the program needs to have some kind of intelligence that interprets your response and gives you an expert answer. So that I started understanding last week when I started working on the display line. So it's going to come. At that stage when you are working on the display line and you start reflecting about what an intelligent system is and how you have got to ask the question to get to the response … to get the appropriate feedback kind of thing. I think at that stage your higher order thinking is going to be quite a lot at this stage I'm not too sure. The reason why I made the comment that the higher order thinking about the model is not taking place here is because nobody mentioned it; I actually listened for that. Everybody is talking about the program issues here so maybe higher-order thinking about the program but not about the model.

I: What I noticed where I saw that higher order thinking was definitely taking place was that this particular group realised that the one question was not applicable if the other option was selected and that to me is a huge understanding of what we are doing and then they came to me and asked

how do we get this to happen, it won't make sense if that question is there, and that is directly related to the domain that we are exploring.

R6: So there is a little bit of that; then obviously but a lot of what happened is how … how do we make that work in the visual interface. But like I say. I think once you get to the display side of this exercise and you start really seeing what your choices above do to your feedback at the bottom, that's when you really start getting the interrelationships between the questions that you are asking and the final influence they have on your message.

Transcript of focus group interview held on 4 March 2011

I: General insight comments suggestions that you would like to share with us?

R2: Umm, yesterday because I didn't do the work myself last time, I played around just with the questions and I could do that so that was a sense, I can do this, accomplishment even though that was basic. But I didn't have my notes so I didn't know what the coding was to put in the IF… I got to the IF and then I got stuck. I couldn't remember what you said but there was something in my subconscious I remembered. If I don't know what I do is right click and I look at all the options and I think maybe this one maybe that one. So I got to the IF statement but I didn't know the coding so I couldn't go any further so I did that this morning; then I got stuck, then you made it apparent to me that there must be an answer, that text value that I didn't put in. so I went off and I did the coding IF this and this and this and this and then that must be the answer, so I did all of this and then nothing happened. So when I spoke to R3 she said that not the questions but the answers don't work or might not be apparent to the user that … things that we assume that everybody should know are not so. So the reason why I think that people need an expert system is to tell them, be

very basic, if you do this then go on to this or this means … if you choose a suit then it is formal. So obviously people will learn something else. Not just the programming of that.

I: How is this influencing the depth of understanding that you are achieving?

R2: Umm, it did because I'm not a logical person but if you struggle a little bit then you understand if you do this then this will happen; if it doesn't happen then it means something is wrong; then you have to go back and find out why and think but why didn't it work what went wrong, so I think that there is learning in that.

I: But that seems to be confined to the logic of programming itself.

R2: Not it's not; it's your own logic as well, the logic of the concept.

I: Is it improving?

R2: Yes, I well I hope so; I think that everything you did before they started working on the programming also made sense. R6 said that we worked on the flowchart beforehand because that made sense to us. But when we started working on the programming we saw that there were some flaws in the flowchart that we did in the beginning. For me still this works better to initially just pinpoint the questions for myself and then what I think should work and then when we do it and see that it doesn't work then we can go back and say OK why didn't that work? Was there something wrong with our questions here or the IF THEN statements?

I: Just one last question for you R2; what was missing in the flowchart?

R2: Maybe it was the questions, there wasn't a specific IF THEN statement to get to an event in the end; I think that was maybe the problem.

I: OK, thanks.

R3: I would like to elaborate on what R2 said because we initially worked together. What I found was that I got stuck at a certain question and then I realised that I am actually almost giving them multiple choice. Choose one and then the next but real-life does not work like that. So you would have to input into the program so that the inference engine can give advice you would have to input more underlying information and then we make assumptions about concepts we assume that the model the CMAPP, we assumed that the students … we worked on our knowledge not what the students would have and R6 made me aware of that. Because if we say formal informal it's not necessary that they would know what formal informal is. So in that way you asked R2 questions about the system and the concepts, so in that way I looked at the concepts of the model again and realised that you can't make assumptions that people would know things. You have got to go back to the real-life situation and think, what would they see there and you would have to make provision for that. And also if I worked through the whole thing it would be IF THEN IF THEN but I could only work on the one leg of formal and that would disregard any other choice that the students would have made and we would have had to do a whole different level which I'm not sure we would have approached that.

I: Now tell me something; how has that modified your understanding of a formal context?

R3: It has, because I would say formal is, formal is if the people wear suits in an office that would be the off the tip of your answer that you would give. But formal can take different shapes and a student could … or someone approaching the expert system could come with a specific idea what they

have seen, so the expert system will be able to give advice based on that because there are so many variables and factors that come into that.

I: So by trying to articulate that within an expert system environment has modified your understanding of formal really is?

R3: I would say more to the extent of how the students would experience that but yes, to a certain extent yes, because it's not just an answer that you can give someone. And also if you get to the end, umm, R6 told us that R5 and them they worked basically you put in your IF THEN statements from the bottom so that you don't have to choose this choose this and then that and then I thought, *So what is the answer now.?*So the logic developed and my ideas of the concepts developed also. And I also got an aha! moment about OK, this is what an Inference engine should be doing.

R6: Umm, I think what happened to me in terms of learning about the model itself and the components of the model once we had the aha! moment of what an inference engine really is then it forces you to start looking back at what it is that you are looking for to decide, for example, that the tone is formal or the tone is informal. Umm, and once … what happens then it forces you to pay attention to what the fuzzy indicators of formal or informal. And again I think at this level when you start coding that kind of stuff, that's perhaps the learning that's going to take place. It's about what things to look for if you look at formal and informal, what kind of things in real-life, if you are in a setting what kind of things are you looking for to decide whether that's informal or formal. Because that influences the questions that you are going to ask. So I think that at this level of coding that's where the learning is going to take place. I predict that the interdependencies between the different components in getting to your final product, I think that is going to become apparent right at the end when you start working on your display line. I think that's where that's

going to start setting in. This is to me a hugely enjoyable experience. I'm going to go back and use this and play with this stuff. I worry that we might not know a lot about programming per say, but what we do have is an advantage over the typical student; we have fairly advanced cognitive skills. It makes us deal differently with these kinds of challenges. We have the ability to process differently. I am a little worried that the students will not even progress at the rate that we have progressed at. I think that you are going to have to pay a lot of attention to scaffolding in the class and I think that you are going to have to scaffold far more than would be necessary in a group like ours where the cognitive skills level is higher than you would typically find in a group of students.

I: Tell me something, the fact that we all have a reasonably good understanding of the concepts that we are exploring, is that not making the learning as apparent as it might be to the student?

R6: You told us right at the beginning to take the textbook and go and read this chapter. And that's where I happened on the idea that perhaps our cognitive skills are perhaps a little more advanced. Because that to me was enough to understand the concept, so I walk in here and I already have an understanding of the concept so the whole exercise in that sense was a little artificial because I know where we are going towards. Whereas if you are working with students who have got no idea at all, the learning might very well be different to what occurred in this environment.

R5: I think what's brilliant about the expert system is that students have to reflect on their learning, so it's not just … yes, they create a database of information but if they get this right they will turn this information into knowledge that they can apply. So I think that this makes this like constructivism, higher-order learning. It's not just learning a collection of

information they have to infer knowledge to arrive at a decision. So I think that the reflection process is very …

R3: Can I just add one thing? What this did for me is to change the way that I would teach something like this if I had to teach it again because it forced me to look at it the way that a novice in the area would approach this. So that was also an eye opener to me.

I: So it changes the way that facilitators understand what it is that they should be communicating?

R3: Ja.

R6: I think what would have happened for me if I had to teach this subject is that once I read it I had an understanding of the model but it was tacit understanding. But because we have worked on this development it kind of pointed out very discreet things that you look at. Discreet observations that you have to bear in mind to get to your understanding which at first was tacit but now I can actually tell you a range of things that explicate this tacit understanding. And now when you need to teach that … because you have got a tangible list of things that you were previously intuiting you have now got a list of things that people can actually look at. That's what it did for me it kind of concretised the small little things that you need to look at to get to this previously I would have had an intuitive understanding of whether it was informal or not and now I can actually tell you, if you look at this and this and this you can decide that its formal.

R3: What it did for me also, it was …. We used to teach here, because of time limits, because of English language proficiency, because of all of those reasons, we used to teach and listen, this is the answer and this is it. What this made me think about was different personal understandings of

concepts and that you have got to make provision for that. So you have to allow the student to develop his or her own understanding. And you have got to make provision for that and that is why I think the expert system that we had to develop could become so massive because you have got to make provision for that and where do you draw the line? Because my understanding isn't the students' understanding, isn't the next student's understanding and if you really want constructivist learning to take place you have got to keep that in mind.

I: Anything else? Thanks very much.

Addendum G
Transcripts of focus group interviews held with the student sample

Transcription of focus group A
(No editing of responses)

Researcher: What do you guys feel about using computer technology to learn in this way?

FG 1.1.1: It makes life more easier because computers have become more influence to our lives at this period of time.

Researcher: And learning Communications using computers by creating an expert system, how are you finding this? Challenging, interesting annoying, disruptive?

FG 1.2.2: I think that it is very interactive. Kind of a way exposes you to the outside world because I think that expert systems are being used outside for different purposes and then this gives us a broad of how communication can be used and expert systems cause I didn't know expert systems before today and knew what it was … I had probably used them but I didn't know what I was doing but now ...

Researcher: Anyone else? Yes, Sir?

FG 1.3.3: I found it interesting because some of us we learn easy doing things practically.

Researcher: Anyone else?

FG 1.4.4: I found it interesting. You know … let's take … if it was information technology; the world will be the same. The expert system is very good, for instance, the introduction, you told us like if there was like old men who's having minds about something for like if you want to go to job interviews and all this stuff. So it is good the expert system, its helping for … its working like humans mind, ja, I think it's helping.

Researcher: Anyone else? How is this affecting how you understand the subject? Remember we are here to learn about communication; how is it influencing how deeply or how well you understand what communication is about?

FG 1.4.5: It improves our communications. Like we learn what our managers out there in the business world expect from us.

FG 1.5.6: It does improve communication in lots of ways but at the end of the day there is a disadvantage to it. For example, we are the only ones actually … if you are doing IT; we are the only ones who know what expert systems are. If you have to introduce this subject to other courses like management or HR or whatever then I think it will be influential because we are not the only one who are doing communication we are not the only one who are communicating, we are communicating with other people out there. So it would be better if this was introduced to all the courses that are in this campus.

Researcher: What I'm really trying to ascertain is how is the process of developing an expert system influencing how well you understand communication. Because basically what we have been up to over

the last couple of weeks is, we have been developing an expert system. How is the process of developing that expert system influencing your understanding of communication?

FG 1.3.7: It's working, that's what I want to say, it's working. Why am I saying it's working, why? All those videos that you showed us, like I could have just looked at them and thought , you know, I don't care, but after I've seen them then I could see, OK there was a problem there what was the problem. Like we were using CMAPP, I didn't know what CMAPP was but now out there, when I'm outside … the other day I was walking and seeing two people talking and I was able to apply CMAPP to that … I was watching TV and I was able to apply CMAPP to context … especially context because we didn't do message and all those others. It's very influential.

FG 1.6.8: And again the expert system it gives you ah… it broadens your mind. Like you won't think as an individual but you will think for the other person, you will think out of the box, you see.

FG 1.7.9: Just adding to what she was saying; now it's working like she was saying. Now when I'm watching a movie or something, before I'm watching the movie and OKOK its funny they're laughing like doing stuff, but now I pay attention try to take like something from what they are saying and know what they are talking about. When we have to do something now we don't just do because like it benefits me. I have to think, if its fine for me it will be OK or understandable for others. Like other people. I think that's the way the expert system is

FG 1.8.10: OK, like what I saw from the previous thing, I mean ah views, learned that ah, like there in ah industry, it's not just all about the

employer it's also about the employees and the people around you, they contribute a lot to your communication and your listening skills.

Researcher: And has actually developing the expert system given you that insight or is it just your exposure to CMAPP that has given you that insight?

FG 1.3.11: Exposure to CMAPP.

Researcher: And how has developing the expert system influenced your understanding of CMAPP? Cause now you have to think about the expertise that the expert system is designed to mimic. Are we still too early in the process or are you seeing something happening inside your minds?

FG 1.3.12: It's still introduction it's still very difficult, because for some of us it is still even difficult to apply CMAPP, its difficult, the programming, everything is still difficult, we are still learning, we still having problems with the IF statements. So it's still introduction, getting there.

FG1.8.13: Yes, like we are still in the process, I think more time will be … We will get it.

Researcher: How is struggling the way you are struggling influencing the way you are learning because sometimes when we struggle we learn?

FG 1.8.14: Ja. I was struggling to have great outputs because by the time we are struggling is … we keep on asking others and then we have better outputs and then the great answers and stuff.

Researcher: So the struggling is making the learning more …?

FG 1.8.15: More better, ja more better.

FG 1.3.16: Because the more you struggle the more you ask questions.

FG 1.7.17: And the better you approach questions you know, the better understanding you have for ja …

FG 1.5.18: It's great because the output of the debate is the correct answer so if you debate and then you are going to have the correct answers and then you are going to do the great thing.

Researcher: How easy is it to learn using the software? Is the software easy to use?

FG 1.3.19: It's easy to use 'cause we have done programming before. Before you start ... we have all done Visual Basic so, umm, IF statements it's easy to use that output like you already understand that language. But if you are not doing IT it's going to be very very difficult. But because you have done programming before, and some of us are still doing programming, it's very easy. You actually see that in programming … it's the same thing except it's a different syntax, it's the syntax that we use that's different.

FG 1.7.20: Ja, we are applying the same knowledge like it's the same as Java, everything that we do there its Java stuff. If we do Visual Basic, which is the basic of IT, we are going to do this stuff.

Researcher: And tell me something you guys, are you enjoying this?

Group: Ja, Ja.

Researcher: All of you are enjoying this?

Group: Ja.

Researcher: Would you like to learn all your subjects like this?

Group: Ja.

FG 1.3.21: No, It's a little difficult … it's difficult. But I think learning using different things. If in all my subjects I was using one thing … you are not exposing yourself to other things. So it's good when you are doing programming using this software, theory you learn how to read because If I didn't know how to read I wouldn't know how to apply you knowledge in this. So you need your programming yes, and you need your basics, you need your theory.

Researcher: So you would like a bit of variety; you don't want the same style used for everything?

FG 1.3.22: Yes.

Researcher: OK, but you guys are enjoying this. What's not working here?

FG 1.7.23: At first when you started talking about the expert system, I didn't understand ... like ... because I thought we were doing a basic program, because we do programming like where you put in certain inputs and then you get a specific answer. But now after you explaining ... like after a few classes I started getting the fact that this system actually, umm, accommodates like a whole lot of situations. It's like you give it a problem and then it gives you a

solution and then the problem, doesn't have to meet like all the conditions but then it gives you like advise, you don't have to solely take it but, you understand.

Researcher: But yes, what's not working? In this whole learning experience, what's not working for you? What do you find irritating or do you think can be done better? What would you say?

FG 1.7.24: I think more practice on the expert system would actually be … if we were more comfortable with the coding and the …

Researcher: Anyone else?

FG 1.3.25: The coding, you know when it comes to the IF statements; I don't think that it's working because everything there it's cluttered, like it's really cluttered. Like in VB it comes in steps, you know, this is the first step this is the second so everything there it's just one line, like if you had to read that, if you had to give somebody who hasn't done programming like they wouldn't be able to read that. So I think the method there when you use your coding if it was ... step by step it would be easier.

Researcher: So you say that using the software is a little challenging because you can't see the logic of your argument in one view?

FG 1.3.26: The user interface; its fine and the coding.

Researcher: And the way that we are doing this, giving you an understanding of what an expert system is, giving you an understanding of the expertise, does that make sense to you guys?

All: Yes, it's making sense.

Researcher: OK, does anyone else have anything to say, just generally, just anything?

FG 1.7.27: I want to ask, if ah, if there are possibilities to change the software. Because we are the student, we are doing the English, but some of them they are not doing programming so it's very difficult for them to be on the same level as we are. OK for me, when it comes to the IF statement I can see, because using the operators I can use them but to those that are not doing Java or other languages is difficult. At least the software ... if they can change it.

Researcher: Do you think that the more the people use it the more comfortable they will be with it?

FG 1.7.28: Ja, I think so.

Researcher: So maybe that's just what you are feeling now, maybe if I ask you in another two weeks' time you will feel different?

FG 1.7.29: I don't know.

FG1.3.: I wouldn't feel different because like I said anybody who is doing Logistics, if they had to come … I think it will … for us it to OK just a few days to understand it, why? Because we have done programming before. Someone who has done logistics knows nothing about programming. All they know about computers is typing, that's the only thing they know, yes, they know a bit of PowerPoint, they know a bit of Microsoft but they know nothing about programming. This is programming.

Researcher: So what would the solution for a Logistics student be?

FG 1.3.30: The only solution would be to use the expert system. They are the end user.

Researcher: But I want to get them to create it, because creating it is where the learning happens; using it is not where learning happens. How would I get them to create it? You say the software would be too challenging for them; how would I make it easier for them?

FG 1.8.31: Sir, each and everything like the first time you learn is challenging, even for us, OK we have done the basic VB before. It was challenging but then we managed to pass it. Even for them, it's going to be the challenging at first. Each and everything at first is challenging, but the out puts it's there…

FG 1.3.32: Eventually, but it will be a slow process.

FG 1.8.33: Can I ask a question? What is your final plan? Is it to incorporate this type of learning in every subject? So your plan for us was to use the expert system to get us to get more of an understanding regarding communication?

Researcher: Is that happening?

FG 1.8.34: Well I can say that I realise that communication is a very very broad ….

Researcher: And actually thinking like an expert and designing an expert system made you realise that?

FG 1.8.35: Ja, that's what I can say.

Researcher: And is that helpful to you?

FG 1.8.36: Ja, it's helpful in way 'cause …

Researcher: It's given you a new understanding of what communication is about?

FG 1.3.37: If this is just for us only then, and communication is broad, then it's not really communication because I am not always only communicating with an IT technician, I'm not always communicating with these guys. When I go to the industry, when I finish this and I go to the industry I'll be working with somebody at management level or in HR because I'll be helping them 'cause everybody is using computers. I'll be the one who is solving their problems with computers, right? So I'll be communicating with those people, so if I come up with this and I say this is your solution, if you do one two three … it's going to be difficult for them. So I think this thing, this software should be introduced to everybody, whether Logistics or HR or whatever.

Researcher: It's not about the software; it's about your understanding. The software is only a tool that enables you to understand something at a different level. Is that happening?

FG 1.3.38: Oh, yes, that is happening.

FG 1.7.39: Yes, that is happening.

Group: Yes.

Researcher: So by creating this expert system you are understanding communication at a different level?

All: Yes, yes.

Researcher: So everyone kind of agrees to that?

FG 1.3.40: Definitely.

Group: Yes.

Researcher: Because that's the idea. The idea is not to actually develop a piece of software that can be used by marketing people. It is to improve your understanding of what communication is.

FG 1.3.41: Oh …

Researcher: And you are telling me that that is happening?

Group: Yes.

FG 1.3.42: Yes, that is happening.

FG 1.7.43: 'Cause like when you record the software, it seems like you will make like the user, the user's mind. The user is going to click and is going to mimic like I am the one who is going to mimic the user's mind. The mind like I don't know that person but I like it is improving like …

Researcher: Your insight?

FG 1.8.44: ‘Cause communication is broad it is all about understanding and I think all of us we … I mean we found out the other things that we didn’t know … Isn’t it?

FG 1.3.45: Ja.

FG 1.7.46: If maybe inside some body’s mind that would know that you are great, like your communication …

FG 1.3.47: Communication skills are good.

Researcher: All right guys. Have we finished? Is there something that someone wants to say?

Transcription of focus group B

(No editing of responses)

Researcher: For the past three weeks or so we have been talking about expert systems; we are now using a software application to develop an expert system. I would like to get some understanding of what you feel about what we are doing.

FG 2.2.1: It’s complicated.

Researcher: Why do you say so?

FG 2.2.2: Because we are doing some ... Like the examples you gave us were easy, about the dog or whatever but now we have to create something that has to tell people what to do, which is hard.

FG 2.2.3: And communication is really broad; it’s like a broad subject, so most of us don’t really know where to start.

FG 2.3.4: The advantage about it is like, I think the person who benefits is the end user after all, it's complicated for us but after the final product it's beautiful. It's easier for the user to use like, with those dropdown buttons … it's exciting. Even though it's complicated and it's hard to create but the final product is exciting.

FG 2.4.5: I think I am going to design an expert system in the future.

Researcher: You are going to design your own expert system in the future?

FG 2.4.6: Yes.

Researcher: So you are excited about it? You find it interesting?

FG 2.4.7: Yes.

Group: Yes.

Researcher: Anyone else?

FG 2.5.9: I think it gives a clear understanding of what communication really is.

Researcher: OK. Why do you say that?

FG 2.5.10: Because like, there are many things we didn't know about communication but at the moment we know the steps and procedures to follow in order to have a successful communication.

Researcher: It is interesting that you guys say that it is complicated. But the fact that it is complicated does not necessarily mean that it is bad, it does not mean that learning is not taking place. I want to get an explanation from you. How does the fact that it is challenging affect how you understand what we are doing?

FG 2.2.11: The fact that we have little time, we don't have much time to come up with the solution to … is very complicated for us.

FG 2.6.12: We need more time to do it.

FG 2.7.13: If you take time to think what steps to take when creating a system like this you know, what steps that you have to take when you have to present something. Like, it makes you think of those things, you can't just present something; you know the barriers that might occur or something.

Researcher: The way I understand you now is that one of the challenges is that there is very little time to do this, but what I am really trying to get at is the fact that it is complicated allows you to see it in a different way; am I right?

Group: Yes.

Researcher: What is that different way?

FG 2.2.15: It becomes a problem because you need to know what the person is going to say if ... you must have options, you know that you understand what you must do and ... you should be clear you know … if she asks … if a person asks question you must give straightforward answers you must get the point.

FG 2.3.16: And you must probably think like somebody else, you can't think like you think.

FG 2.2: It forces you to think outside the box.

Researcher: How easy are you finding it to use the software?

FG 2.2.17: The software is very easy; it's like Maths, OK not Maths …

FG 2.3.18: Because we are used to programming anyway, we are IT students so we are very familiar with computers and software like that they come easy for us.

Researcher: OK, so you don't think that the software is much of an obstacle to the learning?

Group: No.

FG 2.3.19: It's too easy compared to other programming languages.

FG 2.8.20: It's too much, you have to take your time and study it.

FG 2.3.21: I think the only thing that take time is developing that flow-diagram. Creating the actual expert system doesn't take time; it can take you about 30 minutes' time. But then drawing up that flow-diagram … having to come up with the options and the topic, that's challenging for us.

Researcher: That takes the time? But the actual development of the expert system itself is not an obstacle?

FG 2.2.22: Plotting it down is the problem ... when you have to … think.

FG 2.3.23: Because basically that's … for us as students we feel like we are creating a user interface, we are not coding anything we are just creating a user interface. Those, what you call it, those value names … description … whereby we go to the next window. We are just naming, we are not coding anything in order for that thing to process, we are just coding.

Researcher: You actually are; you are actually putting the logic into that as well by putting the IF statements for the …

FG 2.3.24: Oh, OK maybe that's where the coding comes in.

Researcher: OK guys, are you enjoying learning this way?

Group: Yes.

FG 2.2.25: We are enjoying because we are having more experience.

FG 2.3.26: This thing about working in groups makes it more exciting. Because what I don't know my friend might know, so it makes it more exciting, ja.

FG 2.2.27: We gain expertise from each other.

FG 2.3.28: We know how to communicate better.

FG 2.2.29: But it is also quite challenging I must say, because if some person does not want to work and you want to work and then the other person does not want to think you have to think on your own.

Researcher: So working in groups is also challenging? It's beneficial on the one hand but it's also challenging on the other?

FG 2.2.30: Ja.

Researcher: Gentlemen, do you enjoy studying in this way?

FG 2.7.31: Yes, due to the fact that it is new to us. Each day, day by day we learn new things so that's why it's so nice for us, every day we learn new things on it.

Researcher: Now, I'm also interested to know how is learning this way, by creating an expert system, physically doing it on your own, different from if someone stood up in front of a classroom and just lectured to you? How do you understand things differently?

FG 2.2.32: I think in the end you will remember this, after all the battling and the crying, you will remember it better than if a lecturer just stands in front of you and actually tells you what to do.

Researcher: Why will you remember it better?

FG 2.3.33: Because you are doing it practically, you are doing it yourself, that's why you will remember it better.

FG 2.7.34: It is easier to remember something that you have done practically than something that you have just studied.

FG 2.3.35: And honestly speaking, some lecturers don't know how to lecture. There are a lot of barriers, you find that a person comes in the morning, you don't know if he is moody or that's the way person is.

So there is a lot of barriers between us and the lecturers. So a system won't come in the morning … it won't be moody.

Researcher: OK, does anyone have anything else to say?

FG 2.8.36: We are just willing to learn more, we want to learn more.

Researcher: My last question for you guys: learning that you are acquiring now, will you be able to apply it in practice?

FG 2.3.38: Absolutely.

General: Yes.

Researcher: Why?

FG 2.7.40: Well, I think that's the purpose of the expert system is to teach us, both the creators and the users to actually become better communicators, so I think that it will beneficial because it is user friendly and understandable.

Researcher: Anything else? OK, thanks very much.

Transcription of focus group C
(No editing of responses)

Focus group 2

Researcher: How do you find this experience? How do you find developing expert systems to mimic the reasoning of a human communications expert? How are you finding learning in an environment like this one?

FG 3.1.1: I think it's quite exciting because it is something new for us and we are learning new things each day. Yes, like in communication we are learning new things that we didn't know.

FG 3.2.2: It's very exiting the … this era we living, technology is always on our side so every time everything we learn we try to convey it in technology so that we can be busier, so it can be helpful to us. So I think it's better.

Researcher: Anyone else? What do you feel, Sir?

FG 3.3.3: Ja, it's interesting and it's great 'cause its help people who don't know the communication because for some of them the communication is poor; it helps them to improve their communication as it mimics their minds.

FG 3.4.4: It's very interesting and exciting 'cause I would say it's one of the things that breaks the communications barriers and gives people the broader mind in understanding what communication is and how to use it, how to apply it.

Researcher: Anyone else? OK, I heard words like *interesting* and *exciting*; what is interesting about it? What is exciting about it? Remember ,the idea here is for you guys to be learning. The creation of the expert system is simply a tool that enables you guys to understand communication better. What are you finding exciting and interesting about it?

FG 3.1.5: I find it interesting because it gives me a challenge as a person to think outside the box, not inside to be contaminated and don't think

the right … I have to think … it makes me think broad and using different ways in the way that I communicate with people. Now I know where my errors are when I am communicating with someone and if someone is doing something wrong concerning the communication. That's how I find it interesting.

Researcher: So you say you think outside the box? Just expand on that a little bit. In what ways are you thinking outside the box?

FG 3.1.6: Before I never used to think of ... When I'm communicating with someone I just wanted to get the message across, I didn't look at the environment and the things that were around me that would affect the communication and things that I was doing like, for example, body language, how the person will actually receive the message that I'm saying to them and the tone of voice that I used before.

Researcher: And how has developing an expert system helped you to come to that realisation?

FG 3.1.7: It actually helped me a lot by using the CMAPP; I actually learnt a lot from it.

Researcher: And developing the expert system?

FG 3.1.8: It also helped because I learnt how to use communication in different situations better than in one situation where I have to communicate with friends or a family member or the lecturers.

FG 3.5.9: Just to expand on that, I would say that since we started with the project ... like ... learning experience for some of us. We never

new anything about CMAPP before. Now we know that in communication there is something like it's called *context*, there is something that is called *message* that needs to be conveyed. There's barriers and things like that. It also help us like when we are building one of the projects, that help some of us to guide like ... what can I say. As I'm creating the expert system, I'm creating it from the language that I've learnt from the project, guiding someone who never had the chance to learn about this, by showing him or her that if ever you are using an expert system when you want to convey a message to a certain group, this is the way you should do it and if ever it is for less people, this is how you should do it. This is how is the kind of medium that you need to use.

Researcher: OK; now I hear you say that the CMAPP concept has been very helpful to you. How has your understanding of CMAPP been affected by the development of the expert system? How has it been changed?

FG 3.4.10: Like I said before, we never knew anything about the context, influence of the communication when you are communicating with somebody else. But now since that had come to the play … So that's how it is, yes.

FG 3.1.11: I think also using the CourseLab it was something new for us, we didn't even know there was such thing, such language, it was something new and it was exciting for us and it was interesting in a way to learn more about CourseLab because we didn't know anything about it.

Researcher: OK, and the same question that I asked this gentleman*, How has developing an expert system influenced your understanding of*

CMAPP? I hear that CMAPP has been a useful to you guys because you now understand that communication takes place within a context and so on, but how has being asked to develop an expert system affected how well or how differently you understand that concept?

FG 3.1.12: I think firstly you have to consider a lot of things before you communicate, such as the environment, the way you talk to people. That has helped us a lot because we didn't know that he environment or even some of the barriers can somehow interfere the communication. But knowing where you are … the appropriate place … we know the appropriate place to communicate … like in a meeting we can use a more open place or you can't just call people and say we have got a meeting right now. We have to consider certain places.

Researcher: But how has developing an expert system improved your understanding?

FG 3.1.13: I think in terms of … improve my understanding in communication, it has because right now I can say that we can talk openly with confidence to other people and it has improved my knowledge and understanding of communication.

Researcher: How? Guys, the same question generally, the actual process of developing an expert system, has it influenced your understanding of what we are up to?

FG 3.5.14: Yes, I think I'll be repetitive but let me just say it. Like other my other class mate says …

FG 3.4.15: OK like, it has made things easier for us as a learning tool. Being able to come up with points, I mean like questions which are based on the, umm, based on the communication barriers and stuff, so they have broadened our understanding towards the communication, that communication is only, is not only a one-way tool, it is a two-way tool; it's all about understanding and listening and ... ja.

Researcher: OK, so coming up with the questions has helped you see communication differently? And besides coming up with the questions, the actual development, what has that done for you? Anyone?

FG 3.6.17: It acts as a guideline for communication, as like the questions that you ask … how can I put it …

Researcher: Anyone else?

FG 3.4.18: What was the question?

Researcher: The idea behind developing the expert system is that you guys can think. What do I want to ask? What am I getting at? What is my advice? OK. That is what an expert does. That is what an expert system is designed to do. Are you guys doing that? And how has the process of doing that changed the way you see communication, changed the way you understand communication? OK let's think about that. What do you guys find challenging about this process? Developing an expert system, using technology in this way; what is hard for you guys?

FG 3.5.19: The audience sir, when it comes to audience, like in a meeting OK I know in a meeting there are audience, but what if I am sending SMS or fax, is it also part of audience because CMAPP includes audience only.

Researcher: OK my question was, umm, using technology has certain challenges. What are you guys finding difficult about using technology in this way? Is the development environment easy to use? Is CourseLab easy to use? Working in groups, how is that working for you guys?

FG 3.4.20: Working in groups is like sir, like the cooperation, that has been a problem, sir.

Researcher: In what way?

FG 3.4.21: Like you will find that some people are not contributing towards the programming, they are not coming up with any ideas towards the CourseLab thing.

Researcher: And how does that influence your progress in the environment?

FG 3.4.22: Well as an individual I learnt some of the things but I don't know what about the other people who are dependent on others. Are they gaining anything or ...

Researcher: But how is the fact that they are not contributing affecting you?

FG 3.4.23: OK, as an individual I feel that, umm, I've been used in some ways, you know, yes.

Researcher: So you feel that it is unfair?

FG 3.4.24: It's unfair, but at the same time it encourages me to do more because I get to learn other things.

Researcher: OK. Other challenges that people have experienced?

FG 3.5.25: I don't have any, no challenges.

Researcher: And you, madam?

FG 3.2.26: I think using the CourseLab, because, umm it's very difficult because you have to think if your communication model will really help the next person who is going to use it. So it is challenging because about different things, how it will help them or be useful to them and how the end result will be for them. Be useful or not useful. That's more challenging and like he said the groups, you can find sometimes that you don't agree about the same things. We see things differently, so that's more challenging.

Researcher: OK. When you don't agree, how do you proceed from there onwards?

FG 3.2.27: We vote, if maybe it's two against one then we say no we are going to use this, if it's one against two then probably we will not use this at all.

Researcher: And is disagreement good when it comes to learning?

FG 3.2.28: It's not good because it takes us back. We end up arguing and not getting the job done at the end of the day.

FG 3.5.29: I think it's good for me because if you have disagreement it makes you think more to get like better idea or better …how can I say resolution. Because let's say I say something and all my group say "yes" and someone say also "yes", if it's good it's good for all of us. If that idea is like not that really good and someone come up you know, I think this is not really correct, is not good, is better like … to … I think this is not really good but I don't have an idea that is better than this one, all of you will be like, OK, let's all of us think OK, what is suitable for this situation or for this problem. I think disagreement is good, in like a good way of course from there you would be able to think more and more. When you disagree and you think more I think it's better than … for your understanding and your knowledge also.

FG 3.6.30: Disagreements are sometimes really good but sometimes really bad like 'cause we are working with different types of people. There are those people, if ever we are disagreeing … whatever we are talking … we won't come forth 'cause it's like whatever what I am saying the group doesn't want to accept on that. But like on that … it also helps the group to modify to say OK, you came up with something like this but if we are using the very same method that you are using but we modify it to say do like this and maybe as a group we will come together and say but maybe the one that you have just suggested is better than when you started. Like that you ...

Researcher: So it can be good but it can also be bad?

FG 3.6.31: Exactly.

Researcher: What do you guys think?

FG 3.7.32: Yes, it's good sir, 'cause by the time we disagree you are going to get the powerful solution and then if ...There are some of them who disagree even if you try to convince them, then you consult and then you will get the solution that will cover all of us.

FG 3.8.33: I think that its good because in a group, when you are working together, obviously there is going to come a time where all of you don't have the exact same answers, you don't agree on the same thing, so you have to think more and then you have to come up with different ideas and then, as he said, we have to consult so that you get a good answer.

Researcher: Anyone else got something to say there? All right guys, are you enjoying learning like this? Is this an enjoyable experience for you?

FG 3.4.34: Yes, working in groups and working as an individual to come up with some of the things like it really gives one a challenge but also gives you, like let's try to say OK; I had a challenge, I did this, I've proved this, I've done…, I've worked with the group, we have all agreed on the same thing; then as a person you really learn from that.

Researcher: OK. You guys say that it is enjoyable, why? Why are you finding this enjoyable?

FG 3.3.35: It is enjoyable because, like he said, we learnt, let's say in a group, we are developing something or we are discussing about something. From there I come up with ideas, like what I know or what I think that is right and someone else come up with another

idea. From there I will be learning more and my mind, what can I say, going to be more open. Ja, that's what I think is the enjoyable thing, we got … We learnt something new, something more that we didn't know before we challenge ourselves … I think that I'm not like able or capable to do this but finally I did or I contribute something on what we are doing.

FG 3.5.36: I think it is enjoyable because from a group we combine all our knowledge and compare which one is better and … when we find which one is better we used and that one will help us in the group, yes.

FG 3.6.37: Yes, it is good because by the time you can see but no, this expert system that you are going to use, even the people that are going to use, they are also going to argue. So by the time we are going to argue we are going to get the suitable answer that will cover the people that are going to use the expert system.

FG 3.1.38: I think that it is also helpful because we think like experts now and it is preparing us for our future in workplaces.

Researcher: One last question: what can we do to make it better, what improvements can you think of?

FG 3.4.39: The programming language, sir.

Researcher: The programming language?

FG 3.4.40: Yes.

Researcher: What is wrong with the programming language?

FG 3.4.41: You know, umm, there could be some, I mean like those things that could like assist the person who is programming the language because there is nothing there; you are not able to know if you are on the right track. Ja, showing the errors.

FG 3.5.42: To add on to what the guy has just said. I would like to agree on that. Like I would say, CourseLab is a good project to work on as a student, not only in IT but maybe also in other faculties this could be applied. So using a different syntax, like a more user-friendly syntax, ja would also be a great thing to do, would be an improvement.

Researcher: Why do you say that?

FG 3.5.43: 'Cause OK, if I am in IT and I am doing this, like I know most of the stuff like Java syntax and so on. But for someone who have never done this before it will also give that person a challenge working with something like this.

FG 3.6.44: I find out that its good, the programming is good, that language, but as I learn in French ... that means repeating something is there … it will help you to understand better. I think those exercise we are doing, we are not doing too much exercises. We do maybe two, maybe a week, we will improve.

FG 3.7.45: Just to add on to what he is saying, I think he means we have to, how can I say, we have to have more lessons about expert systems because using CourseLab, its good; let's say for us IT students because we know a bit about programming and like if we learnt

more … we have more things about expert systems I think it will be better for us, ja.

Researcher: All right; does anyone have anything else to say? Yes, Sir?

FG 3.5.46: I think that it should be introduced to other departments so that those people should have that chance to communicate with other people using that expert system.

Researcher: Anything else from anyone? OK. Thanks very much, guys.

Transcription of focus group D
(No editing of responses)

Researcher: How are you finding learning in this way?

FG 4.1.1: At first we thought that it would be just something simple, we get into a lab, we do everything, we get done within one hour but as time goes on we find it more difficult because it needs more time where a group has to sit down analyse everything just to get the work done properly. It just needs more time to do it.

Researcher: OK, thank you. Anyone else?

FG 4.2.2: It needs more logical thinking because when you are doing the program sometimes it becomes more confusing. It become more confusing, ja.

FG 4.3.3: I think it helps you think outside the box ‘cause you have to think beyond your school days. You have to take your communication

level into the workplace and all that. So it helps you think beyond what you like you know your level at school level. ‘Cause now, if I have a presentation I’ll just do it in class in front people but now I have to advise people on how to make presentations in front of shareholders and that, so it takes me to a certain level and I’m thinking outside my box and I’m getting outside my comfort zone.

FG 4.4.4: Ja, I think in terms of adaptability, people who use it will be able to adapt it faster. As for us, creating it is more challenging. And the thing with the time, I think the timing is all wrong. If maybe we had started in February or something, Ja.

Researcher: OK, why do you say that?

FG 4.4.5: It added a lot of work onto our workload that we already had.

FG 4.5.6: It is difficult because when you drafting it on a page it is more easier but when it comes to doing it practically; it’s very difficult because you have to have time and implement all the ideas that you have.

Researcher: Anyone else? Sir?

FG 4.6.7: Actually it’s not difficult, it needs our time to sit down and discuss and plan before what’s going to do first because it’s not that difficult. Ja, but we need to sit down and plan it first.

FG 4.7.8: I think as the person who is designing, it’s difficult for the person who is designing it but for the person who is going to use it its easier and enjoyable for the person who is going to … for the user, but for the designer, it gives a headache. I think so.

Researcher: OK. What most of you have said is that it is difficult and I know that it is difficult, it's meant to be difficult but the fact that it is difficult does not mean that it is bad and it does not mean that learning is not taking place. Give me your insights into that; what sort of learning is taking place because it is difficult?

FG 4.1.9: As we thought, we thought it was going to be just generally, we give advice generally in life but we've got to think it's about communication where learn more about communication. We trying to do something which talks about communication whereas we are also learning how to communicate.

FG 4.3.10: It teaches you to understand the problem before solving it.

FG 4.8.11: I think it teaches us a lot, as we learn the expert system, we gain a lot; we gain communication, we improve our communication. It's like linking … with technology, so we learn a lot. We learn about context and all that. Ja. That is what I think.

Researcher: Someone else?

FG 4.2.12: We are all learning to be better communicators.

Researcher: How?

FG 4.2.13: By using the expert system.

Researcher: How? How is using or creating the expert system making you a better communicator?

FG 4.2.14: In the process of creating, me myself, I am also learning something about communication. Even though it doesn't work at the end of the day but at least I have learnt something about communication.

Researcher: How would it have been different if we had just stood in front of a class and just lectured to you? How would your understanding have been different?

FG 4.4.15: I think it wouldn't have had an effect, or much of an effect on us 'cause of the different personalities. I mean, if you tell someone that you should do this or that … it all depends on the kind of person that they are. Like we can't all communicate in the same way so if you create an expert system you are going to use you own views and how people like you would like to communicate. So then it helps you personally 'cause you are going to create something that is going to benefit you as an individual and you are going to understand it. Unlike if somebody tells you that you should communicate in this way. What if it's not something that you are comfortable with?

FG 4.3.16: When it is being lectured it becomes more easier because we are just looking what you are saying, what you are telling us, we are not applying it. When you start applying it, that's where it comes a problem 'cause we have to do exactly what you have just told us.

Researcher: You say a problem; so you are saying that it is not a good thing?

FG 4.3.17: No not actually that, I mean like when you lecturing that it becomes more easier because we see … we think it's simple but when it comes to us to apply it, the knowledge, it becomes a problem.

Researcher: And how does that improve your understanding? Or does it improve your understanding?

FG 4.3.18: It does improve it.

FG 4.4.19: For myself I prefer to do it practically instead of orally so practically I think I get a better understanding practising something, not reading it actually from the boo.

FG 4.5.20: And the fact that we come up with our own ideas, it makes us to think much better because we come up with our own ideas how the system experts should do the work.

FG 4.6.21: I think that when it comes to lecturing, like as we are people we are not the same. Others will find it interesting but others will not find it like a tool to lecture on. So like, umm, I prefer to hear somebody speaking not like to see words. I understand better when something is being spoken to me not like to read it. This expert system I think is going to give me a problem.

Researcher: Why?

FG 4.6.22: Because I will have to read the whole of the options like, as I've told you, if like he was using something like a voice, I could hear it, would be much better ja.

Researcher: OK, remember you are creating the expert system, so I am interested in seeing how the creation of the expert system is helping you to learn. Are you learning by creating it?

FG 4.6.23: Ja. Yes, it make me to become a logical thinker, think out of the box.

Researcher: OK, anyone else?

FG 4.7.24: Yes, as you said about the practical, I think the practical is going to be much easier for us 'cause we have to … you have to tell us and afterwards apply it. I think we will understand it … not each and every day the same, let's say where you end up last week, there is no process there. We have to do some practicals before we do the other expert system like we proceed. I think practicals will be much easier.

Researcher: What do you mean by practicals?

FG 4.7.25: Like not doing one thing each and every class.

Researcher: Do you mean change the problem, change the assignment?

FG 4.7.26: Ja I think ...You have to come with a new idea like when … all of us in the class one problem I think we will develop the …

Researcher: OK. All right now; I would like to get an explanation of what is not working for you here. I have already got a couple of insights like the time issue. I think that it has been quite disruptive because of all the holidays and the exam weeks and things like that. This has made it quite difficult from a continuity perspective, but besides that, what is working?

FG 4.2.27: We getting difficult to give the person like … if the person is asking questions from the expert system, to give the person the correct, exact answers that she wants. It becomes very difficult because in

the expert system every question must also have a solution at the end so it becomes very difficult for us.

Researcher: But that is also part of the learning! That difficulty makes you think about it. Does it make you think about it because it is difficult?

FG 4.2.28: Yes, it is.

Researcher: Are you guys enjoying learning like this? Is it interesting for you?

FG 4.7.29: Yes, sort of.

Researcher: Why only sort of?

FG 4.7.30: Due to the fact of the time. When you get into a lab, ja we enjoy it but when we come out we've got to think about what we did and like just when we think about what we were doing at the lab we gather the fact that it needs more time like we have to sacrifice some of the time, some of our time. We come into lab late, we do the work and then… ja, but when we get into a lab, it's nice and then when you come out we have got to think about what we did there, eish, there we went wrong, there we were right, so.

Researcher: OK. Anyone else?

FG 4.2.31: I think if only we had access to the Internet, that's the other problem of the expert.

Researcher: Why to the Internet?

FG 4.2.32: Because the Internet is expensive. We don't have access in terms of practising.

Researcher: But why do you need the Internet to practice?

FG 4.2.33: Because CourseLab requires Internet in order to access it.

Researcher: No, it doesn't.

FG 4.2.34: Doesn't it? But it refuses to install in our personal PCs. It doesn't.

Researcher: Talk to me afterwards. Umm, OK, Anyone got any final thoughts about this whole thing? I didn't really get an answer from you guys when I asked whether you are enjoying the experience. Is this enjoyable? Is this interesting for you guys?

Group: Yes.

FG 4.6.35: Yes, it is enjoyable. It's kind of interesting.

Researcher: Any you guys feel as though it is constructive, that you are learning something about communication?

Group: Yes.

Researcher: In what way would that be different from just being lectured to you or if it was just in a handout?

Group: Yes.

Researcher: Can I ask just one last question? Why is that?

FG 4.7.36: Mainly I think that it is because it is not every day that we get a chance to link communication with technology. So we enjoy that part, due to the fact that we are doing IT also, ja.

FG 4.1.37: I agree with him; I agree with him. And also incorporate technology into your everyday life.

Researcher: So it makes the learning a little bit more real?

FG 4.1.38: Unlike learning all about computers and you are not applying it to your everyday life then you just learn about it, read about it and then you just move on. But then if it is something that you are going to use every day, or like regularly, in your thing, then it gets more interesting because you know the whole purpose of IT. Like if I am studying IT then my whole purpose is … 'cause it's not just like some random thing, like you just study computers and move you move on. It's going to be an important …; it's going to play an important role in your life, ja. Like almost every aspect of our lives is based on technology, cell phones, the bank, everything, like TV, everything is technology, so ja I think it helps a lot.

Researcher: Now really my last question. What should be done differently?

FG 4.1.39: More time definitely; I would prefer more time.

Researcher: More lab time or more time generally?

FG 4.1.40: More time to do the project because when you are under pressure you don't get the time to actually enjoy something. 'Cause you want to get to the deadline and you miss out on the whole experience.

Because you just want to get to the finish line without enjoying the whole process of it; yes.

Researcher: And, anything else? What else should be done differently? The software? Is the software working?

Group: Ja, the software is fine.

FG 4.2.41: Easy to use; it's not complicated.

Researcher: Anyone got something to say?

FG 4.7.42: At the end we would really like to see your expert system, ja. The one that you did … like this one is the one, we would like to see how did you do it, how did you go for it.

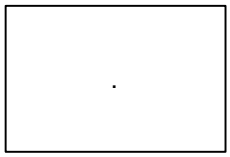
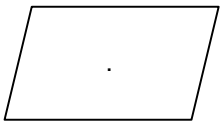
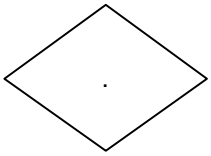
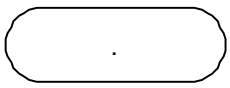
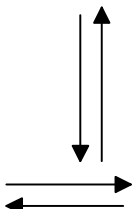
FG 4.2.43: That's not thin, like you always tell us in class.

Researcher: Somebody else? All right. Thanks guys.

Addendum H

Getting to know flow diagrams and IF THEN statements

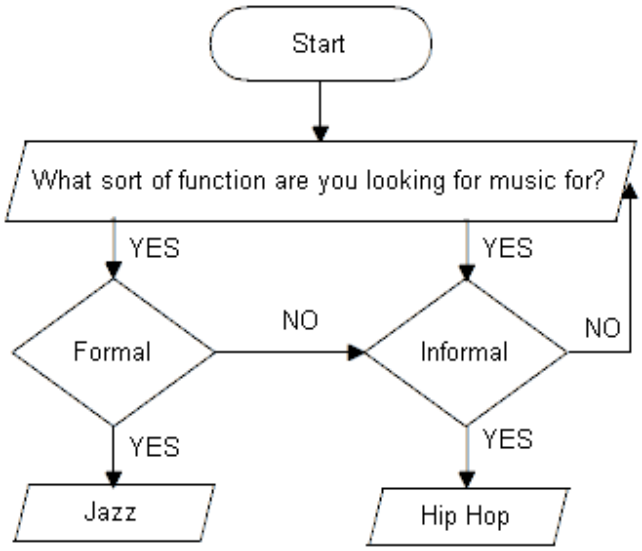
The following symbols are used in the examples and exercises that follow. It is important that you clearly understand how they are used as they will help you to represent the logic of your expert system.

	**Process** This symbol indicates any type of processing that needs to happen. For example, 2 numbers being added together (add 3 + 6) or an item added to a list (add 'Ford' to the list of cars), etc.
	**Input/Output** This symbol is used for any input or output operation and indicates when the computer needs to obtain information or when it sends information out. For example, get an option from the user (i.e. the user is required to select an item from a list of options, etc.).
	**Decision** This symbol is used to ask a question that can be answered with a 'Yes' or 'No' or a 'True' or 'False'.
	**Connector** This symbol is used to join parts of a program and can be useful when the program becomes too long and is spread over more than one page.
	**Terminal** This symbol indicates the start and the end of a program.
	**Flow lines** These symbols indicate the direction of flow and connect the above symbols to one another.

The following examples and exercise have been designed to make you familiar with the way in which decisions structures are represented in the form of flow-diagrams and IF THEN statements.

Let's start by looking at a very simple example: *Choosing the most appropriate music for a function*

A flow- diagram that outlines the logic used to decide what music is most appropriate for a particular function could look like the one below.



The same sort of decision structure used in the diagram above could be expressed in the form of a simple IF THEN statement such as the one below.

IF Formal THEN
    Jazz is appropriate
IF Informal THEN
    Hip Hop is appropriate

Exercise 1

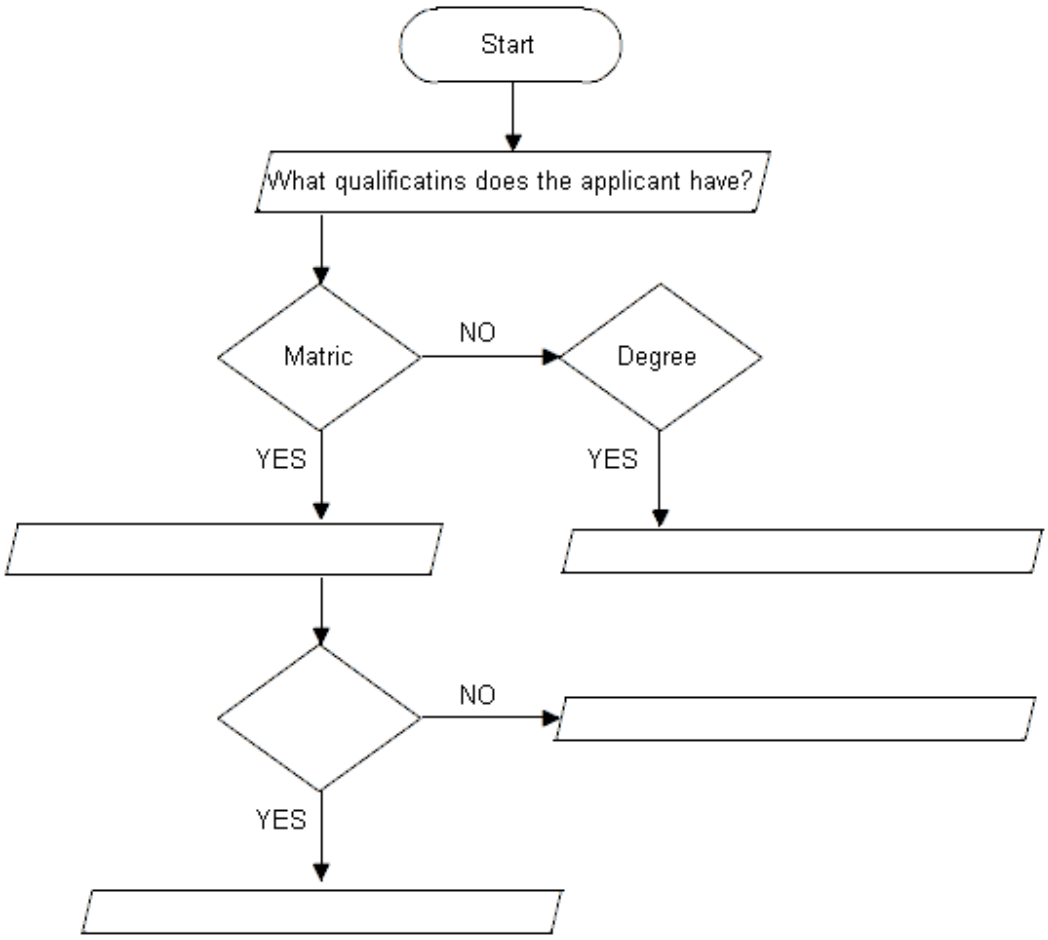
Represent the following IF THEN statement using a flow-diagram such as the one above:

IF the object has corners THEN
    it is a box
IF the object is round THEN
    it is a ball

Exercise 2

Complete the flow-diagram below representing the following IF THEN statement:

IF candidate has a matriculation certificate THEN
    IF the candidate has experience THEN
        send an invitation letter for an interview
    IF the candidate has no experience THEN
        send a letter declining application
IF candidate has degree THEN
    send an invitation letter for an interview



Exercise 3

1. In your groups, think of a simple real world problem that would need to be solved by selecting a series of options similar to the examples used above.

_____

_____

_____

_____

_____

_____

_____

2. Represent this problem using an IF THEN statement.

_____

_____

_____

_____

_____

_____

_____

3. Represent this problem using a flow-diagram similar to the ones used above.

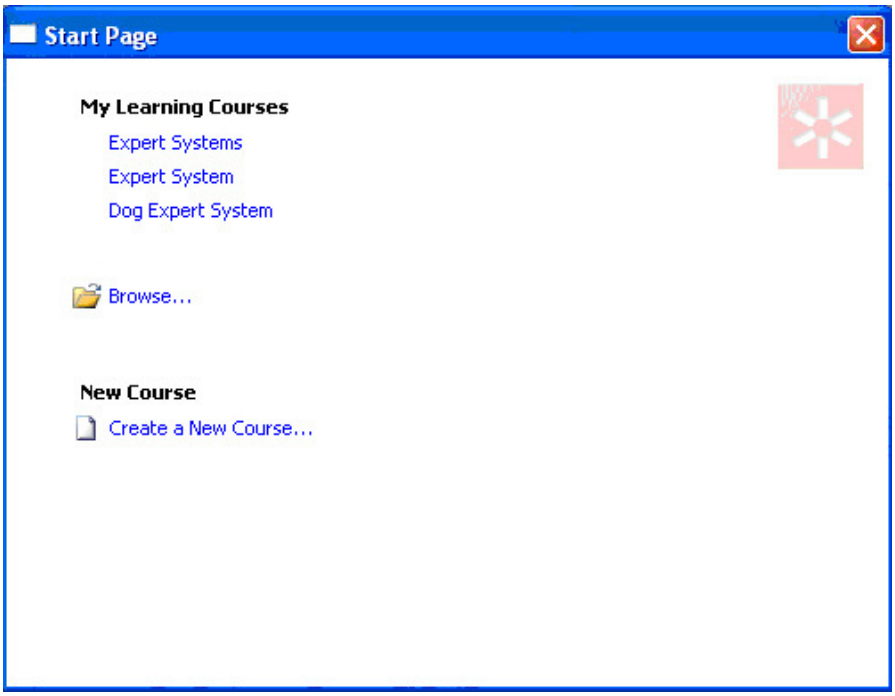
Addendum I

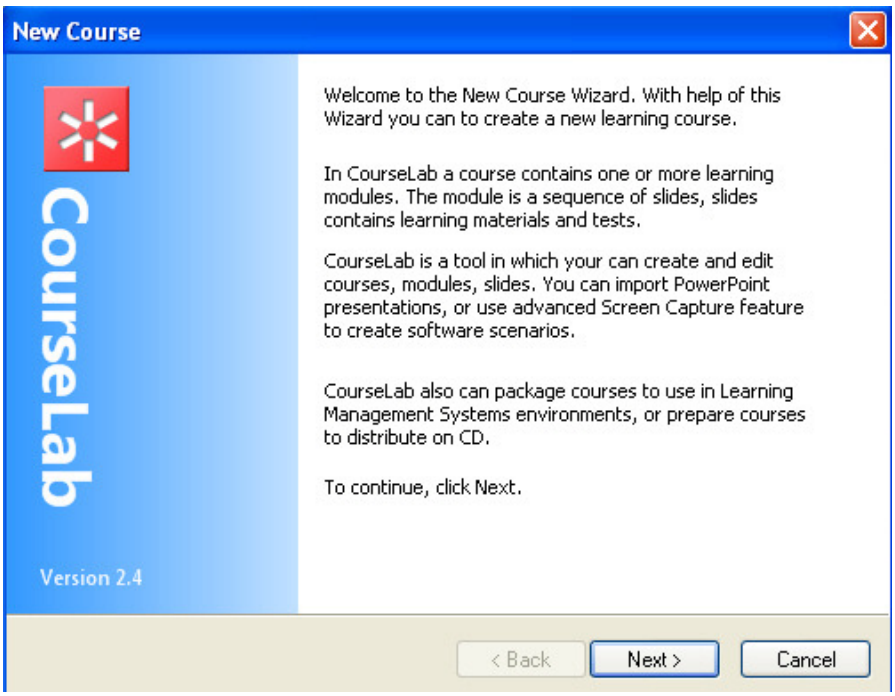
Step by step guide to creating an expert system using CourseLab

The basics of using CourseLab

Step 1 Open CourseLab by clicking on its desktop icon.

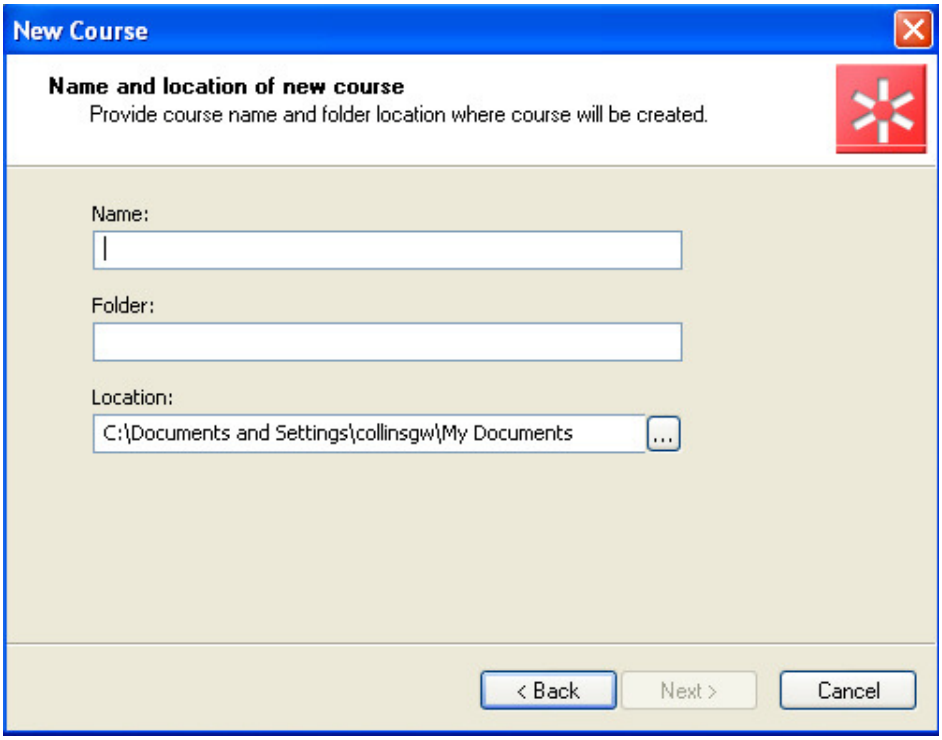
Step 2 Click '**Create a New Course**'. This will open the 'New Course Wizard'. Click 'Next'.



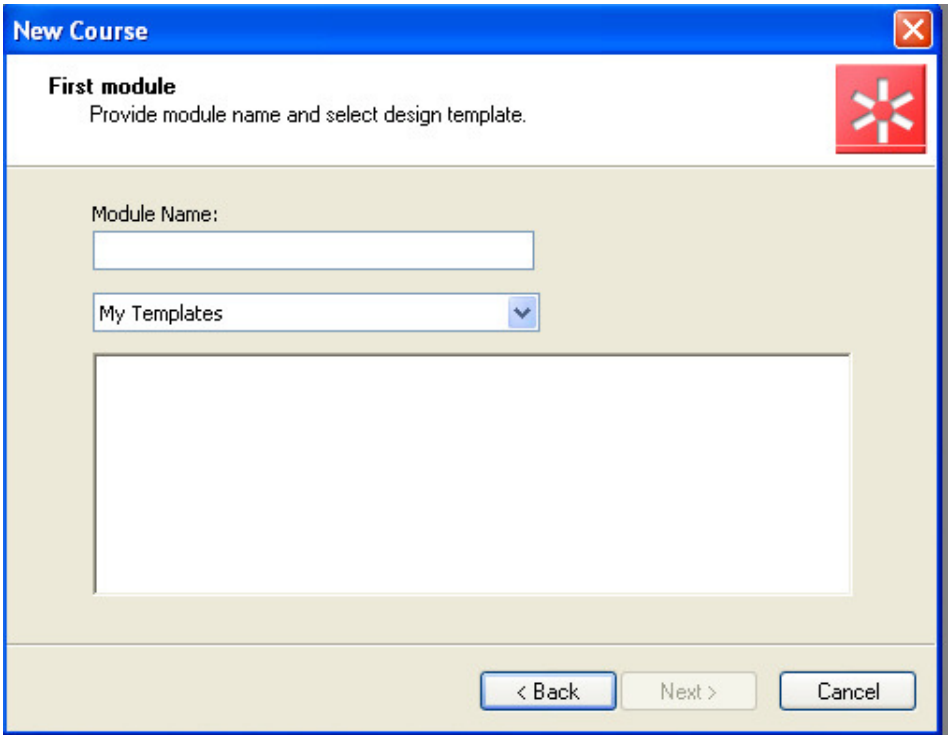


Step 3 Enter a name and location for your ‘New Course’ (Remember you are not really creating a course; we are simply using this teaching software as a tool to create an expert system).

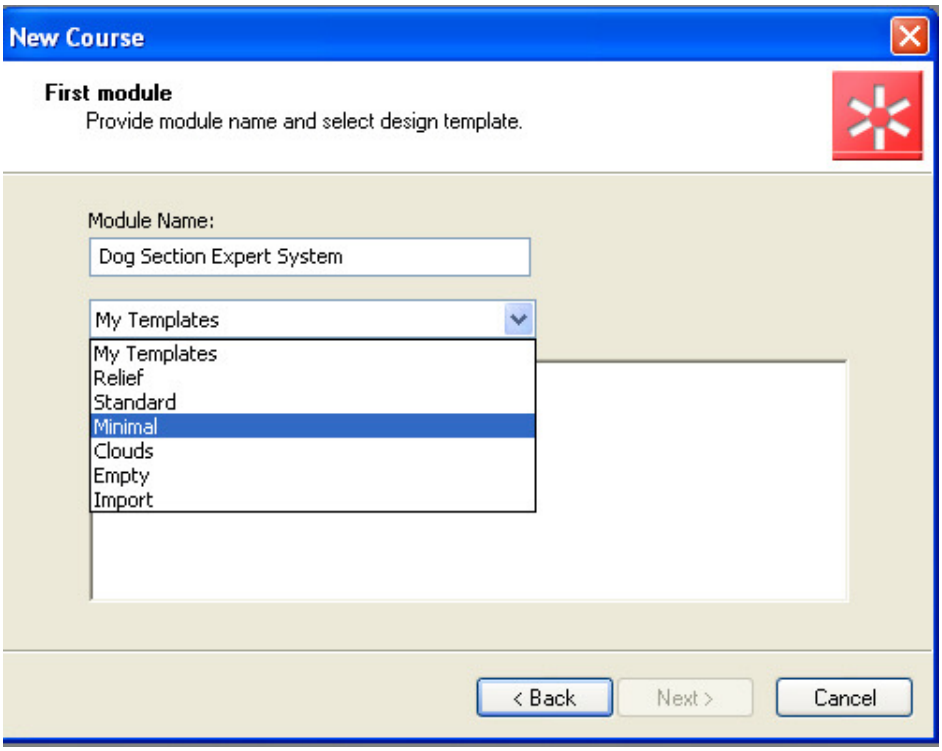
Step 4 Enter a Name and Location for your ‘New Course’ (actually your collection of expert systems). Then click ‘Next’.
A suggestion is: ‘Name=’Expert Systems’ & Location = ‘Expert System’.

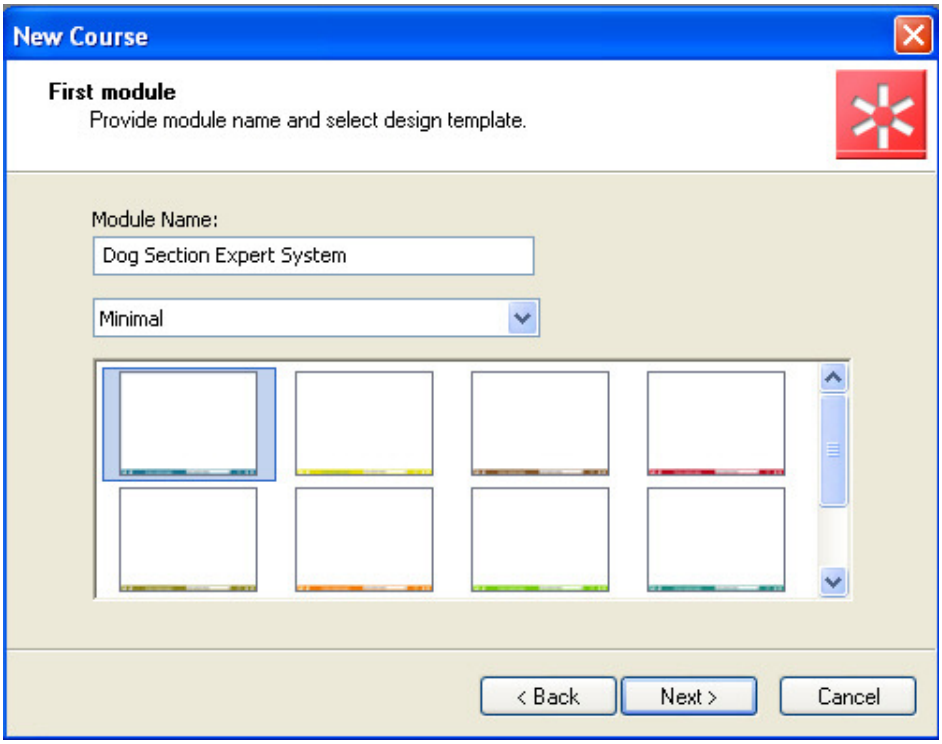


Step 5 Enter a ‘Module Name’ (Actually the name of your first expert system) Then click ‘Next’.



Step 6 Choose a ‘Design Template’.
Suggestion: Choose one of the simplest ones, ‘Minimal’.
Then click ‘Next’ & ‘Finish’.

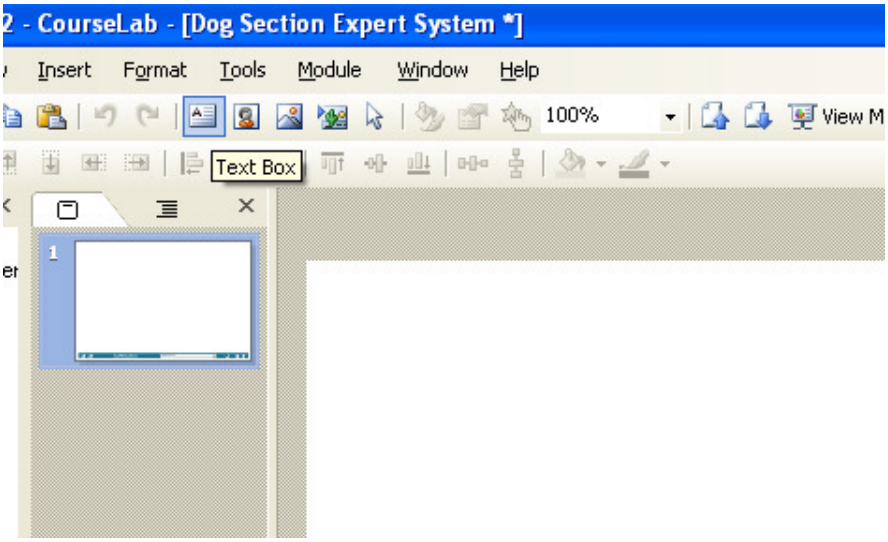




You now have a blank platform on which you can create an expert system.

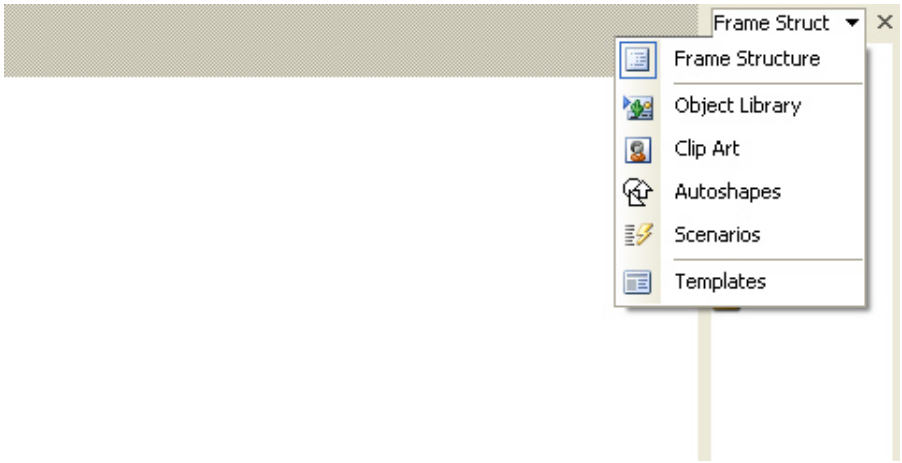
Creating the expert system:

Step 1 Remember an expert system guides the non- expert user by asking questions. One of the simplest ways you can allow the expert system to 'ask a question' is by typing the question in a 'Textbox' that we put on the screen. Simply click on the following icon in the task bar. A textbox will appear on you blank template; you can now drag the textbox to where you want it.



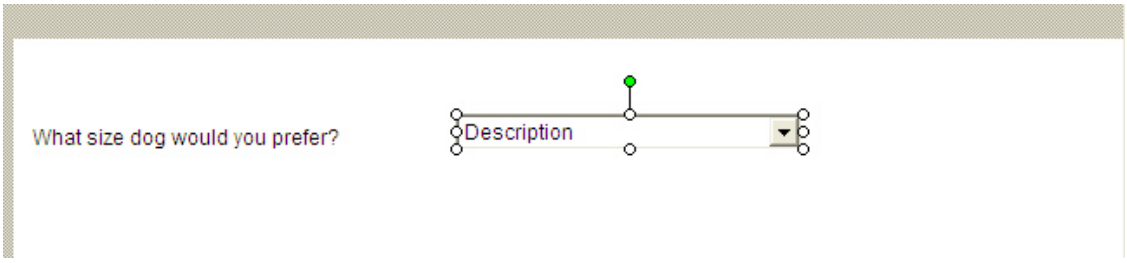
Step 2 Double-click on the textbox in order to type in an appropriate question.

Step 3 Now you have to create a way for the user to respond to the question. One of the easiest ways is by means of a dropdown list that contains logical or appropriate options in it. A dropdown list is an ‘Object’ that is part of a ‘Form’. Click on the dropdown arrow next to ‘Frame Structure’ near the top right of your screen.



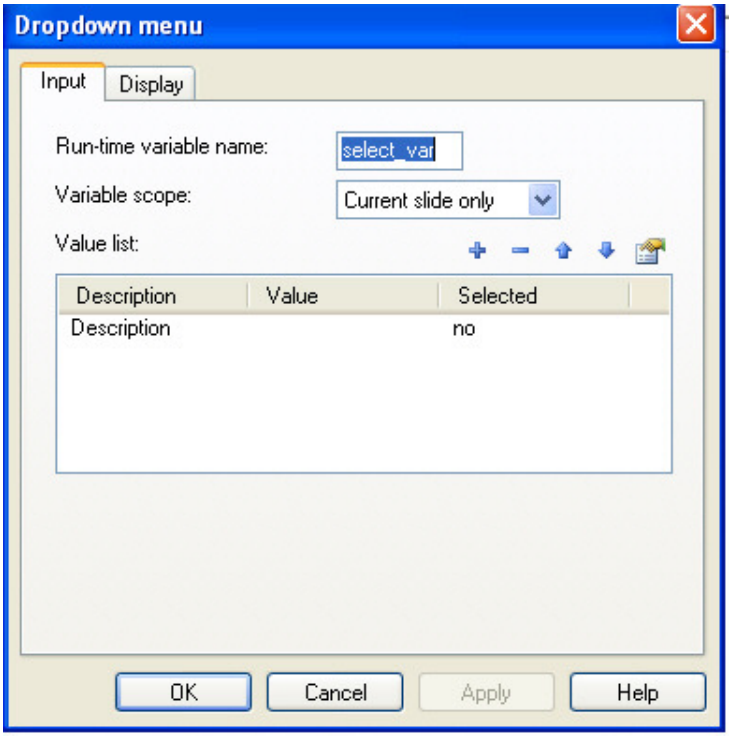
Then click on ‘Object Library’ and then on ‘Form’. You will now see all the ‘Form Objects’ that can be used in ‘CourseLab’.

Select the 'Dropdown list' by clicking on it and dragging it onto your slide.



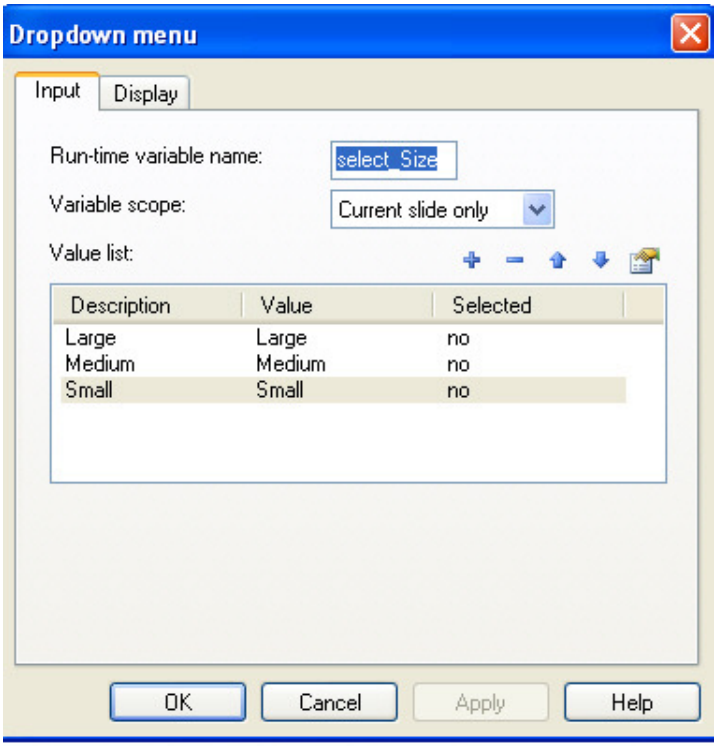
Step 4 Double-click on the 'Dropdown list'; this will open its 'Properties' dialogue box. You can now give it a 'Runtime variable name' and add items that will appear in its dropdown list.

Remember the 'Runtime Variable name' will be used to refer to that particular 'Object' when you start to do your programming.
The items in the 'Value list' are those that appear when the user clicks on the dropdown arrow next to the box. Note that you need to add both a 'Description' and a 'Value' to the items in the Value list.

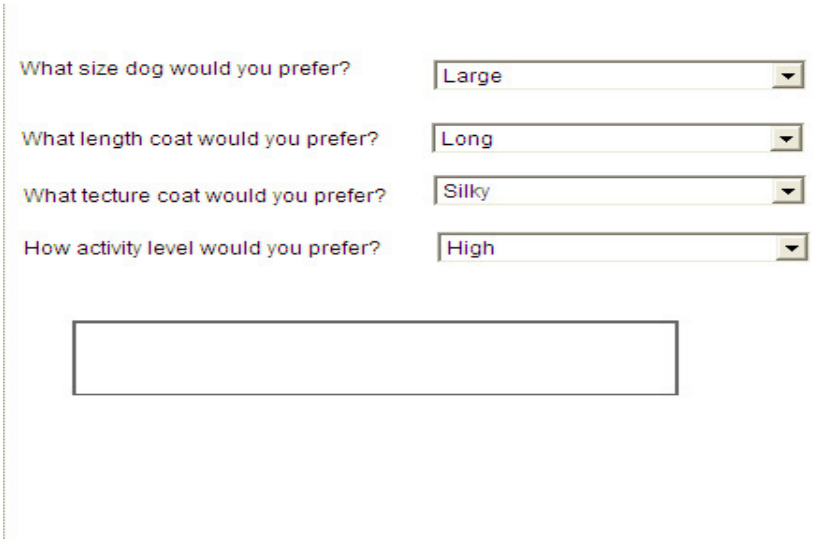


Step 5 Repeat steps 4 and 5 until you have added all the necessary questions and dropdown lists to the slide.

Step 6 You now need to provide your program with a way of communicating the suggested solution to the user. One way to do this is to put a 'Text input' box on the slide. To do this you select the 'Text Input' box from the object library and drag it onto your slide. Give it a 'Runtime Variable name' by double-clicking on it and opening its 'Properties' dialogue box. You add items to the dropdown box menu by clicking on the **+** symbol and then double-clicking on the item in the 'Value list'.

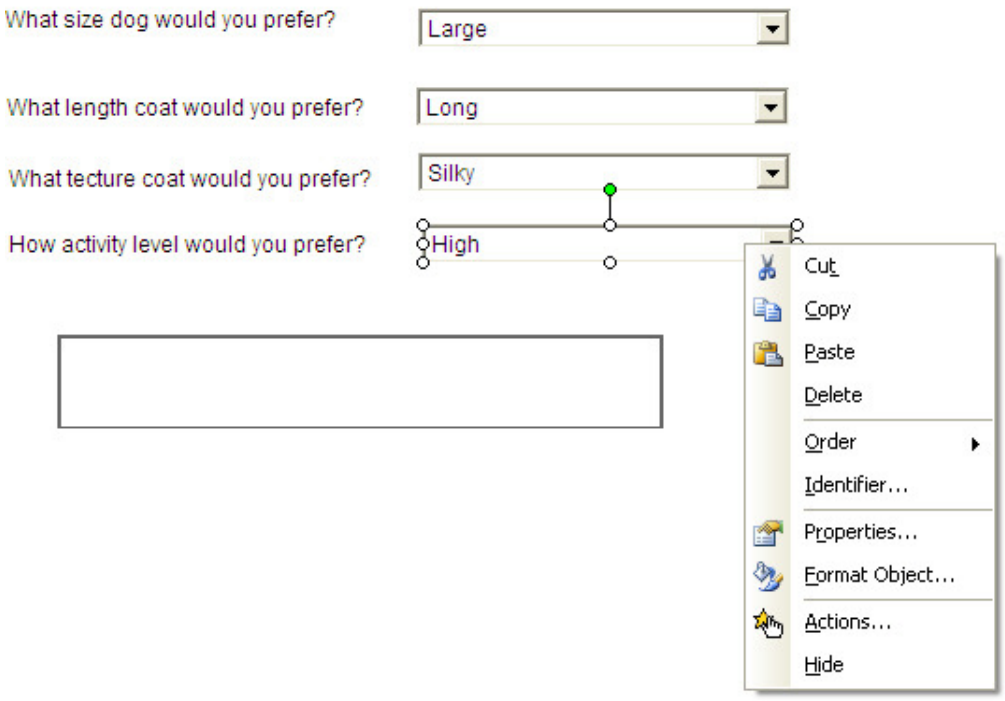


Congratulations! You have created the user interface for your expert system. It is now time to do some simple programming:



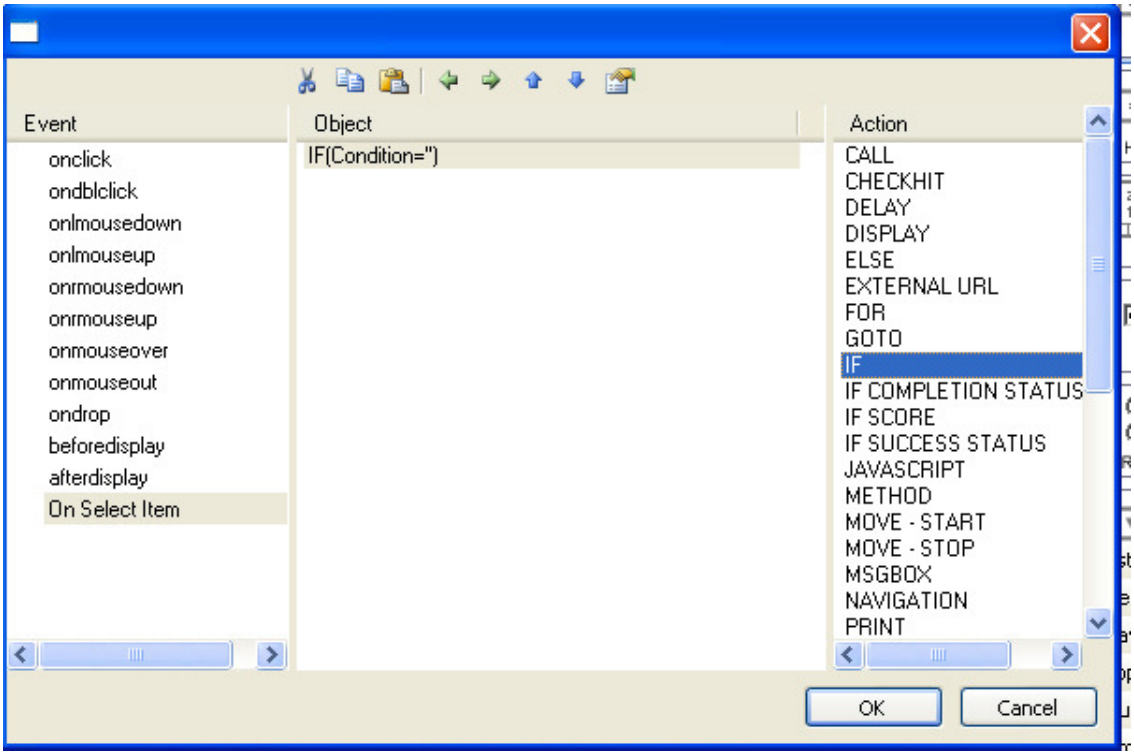
Creating the knowledge base:

Step 1 In computer programming an 'Event' initiates the execution of programming commands. A suitable event for your purpose would be when the user selects an option from the last dropdown list on the slide. Select the last dropdown box on the slide and right-click. Select 'Actions.' This will open a dialogue box that has all the 'Events' associated with the object on the left and all 'Actions' on the right.

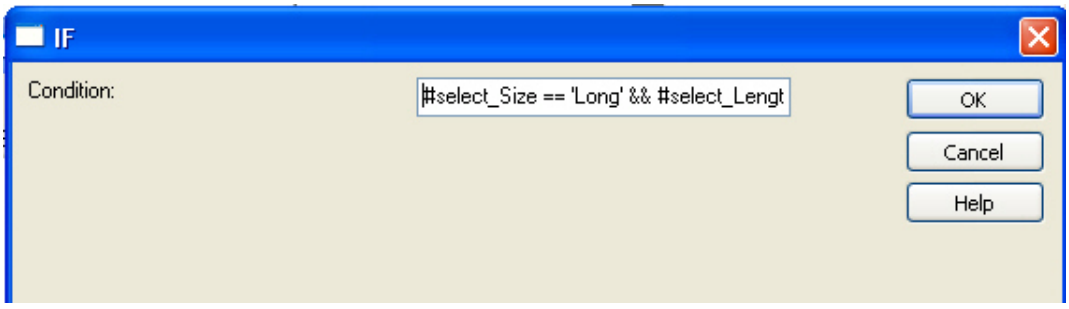


Step 2 Select the 'On select Item' event from the list of events on the left by single-clicking on that option.

Step 3 Select 'If' from the list of actions on the right by double-clicking on 'If'.



Step 4 Now double-click on the 'IF(Condition)' statement in the 'Object' section of the dialogue box. This will allow you to specify the conditions that must be met for a certain action to take place. Type in the condition using '==' to indicate '=' and '&&' to indicate 'and'. If you want to indicate an object you need to use the symbol '#' before that object's name (e.g. #select_Dog_Size).
An example of a condition statement that uses the correct syntax would be: #select_Dog_Size == 'Large' && #select_Coat_Length == 'Long'.



Step 5 Once you have specified the condition that needs to be met it is time to indicate what action needs to take place if this condition is met. An action associated with a particular object is called a 'Method'. We want the 'Text input field' to display the suggested solution to a problem so you want to set its value once a certain condition is met. To do this, select 'method' from the action list. The statement 'METHOD(Object =,"Method")' appears in the Object section of the Actions dialogue box.

Step 6 Double-click on the ‘METHOD(Object =,”Method”)’ statement to open the Method dialogue box. Here you need to specify the object that must do something or change when the condition is met and you must indicate what method that is associated with a specific object is applicable. Select the appropriate object from the ‘Object’ list. Select ‘SetValue’ from the Method list and then input the sentence that you want to be displayed when the specified condition is met.

Addendum J

Common errors encountered when building an expert system using CourseLab

- Remember that CourseLab is **case sensitive**.
- Remember to use '**value'** in you condition statements and not '**description'** (**Description** is what will appear only in the dropdown list; **value** is what is evaluated in the condition statement).
- Remember to use '**runtime variable name**' when you want to refer to a specific '**object'**.
- Remember to use '**#**' before the '**runtime variable name'** in your condition statements, e.g**. #select_qulification == 'matric' && # select_experience == 'yes'**.
- Remember to select the correct '**event**' for an object. For a drop down list the most appropriate event would be '**On select item'** because the execution of the program would only be triggered once the user has selected a specific option.
- Remember to **indent** your method statement to make it dependent on the **IF** condition.

Check list

- If your expert system does not work, go back and check the following:
    - Check that the spelling that you have used for all '**objects'**, '**runtime variables**' and '**values'** is consistent.
    - Make sure that the case (i.e. upper or lower) you used when referring to '**objects'**, '**runtime variables**' and '**values'** is consistent.
    - Make sure you have chosen the correct '**event'** for the applicable object.
    - Make sure that you have chosen the correct '**object'** to display the advice or solution to you problem.

- Make sure that you have chosen the correct '**method**' associated with that object (i.e. if you have chosen an '**input textbox**' to display your solution/advice, then the correct method would be '**setvalue**').
- Make sure that you have indented '**method**' so that it would be dependent on the IF condition being met.
    - E.g. **IF (Condition=#select_qualification == 'Matric' && …)**

      METHOD(Object = 'OBJ_11', Method='setvalue')

Addendum K

Ethical clearance certificate

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Education

RESEARCH ETHICS COMMITTEE

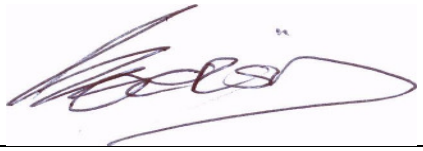
CLEARANCE CERTIFICATE	**CLEARANCE NUMBER :** SM 10/10/02
DEGREE AND PROJECT	PhD Information communication technology as a cognitive tool to facilitate higher-order thinking
INVESTIGATOR(S)	Gary Wayne Collins
DEPARTMENT	Science, Mathematics and Technology Education
DATE CONSIDERED	09 April 2012
DECISION OF THE COMMITTEE	APPROVED

Please note:

For Masters applications, ethical clearance is valid for 2 years

For PhD applications, ethical clearnace is valid for 3 years.

CHAIRPERSON OF ETHICS COMMITTEE Prof L Ebersohn



DATE 09 April 2012

CC Jeannie Beukes
Prof. J.G. Knoetze

This ethical clearance certificate is issued subject to the following conditions:

1. A signed personal declaration of responsibility
2. If the research question changes significantly so as to alter the nature of the study, a new application for ethical clearance must be submitted
3. It remains the students' responsibility to ensure that all the necessary forms for informed consent are kept for future queries.

Please quote the clearance number in all enquiries.