How to help? Investigating children's opinions on help

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Abstract. Evidence from previous work has shown that learners are often unaware of their own learning requirements and are unable to select appropriate levels of challenge and assistance. The introduction of metacognitive scaffolding within educational software should enable learners to become conscious of the support that they require to succeed. However, an understanding of learners' attitudes towards and perceptions of help is needed for a metacognitive scaffolded framework to be developed. This paper describes a succession of studies designed to focus on children's thoughts about challenge and help.

INTRODUCTION

Software scaffolding techniques have provided one way of implementing flexible assistance for students using interactive learning environments. All applications of scaffolding within software aim to offer a means of enabling a learner or a group of learners to achieve success with a task beyond their own independent ability. The actual implementation of software scaffolding differs between systems from providing support to scaffold the learner to scaffolding the task and it's context [1].

Scaffolding the task concentrates upon what and how the task and environment can be structured in order to provide assistance. Task scaffolding is fixed before the learners start interacting with the system[2]. Scaffolding the learner concentrates attention upon how the learner's role can be simplified and how she can be offered assistance by the system. These systems are designed to make decisions about what the learner should do and what feedback she should receive; they rely upon building detailed models of learner knowledge and understanding.

Building detailed models of learners is an activity that is both time consuming and computationally complex. It may be that if learners themselves become more aware of their own skills, abilities and needs that they can take greater responsibility for their learning. This may allow learner modelling efforts to be reduced or to adopt an alternative focus.

In this paper we discuss out initial efforts to find out about young learners' (aged 10 – 11 years) attitudes towards and beliefs about being assisted in the completion of a particular task. We describe a series of empirical studies designed to motivate discussion with these learners. We need to understand more about why children do or don't accept help when it is available, what sorts of assistance they find helpful and what they belief computers can offer in terms of assistance. The answers to these questions will be used to inform the design of some metacognitive software scaffolding techniques.

ECOLAB – THE ROLE OF METACOGNITIVE SCAFFOLDING

The 'Ecolab' is an example of a system that has been implemented following a design framework that incorporates both learner focused and task focused scaffolding. The 'Ecolab' is an interactive learning environment with which children aged 10 and 11 years can investigate food chains and webs. It explores the possibilities offered by domain level software scaffolding techniques and investigates the effects of varying the balance between learner and system control. The software in its current form provides the child with the facilities to build, activate and observe the relationships that exist between members of a food web. The complexity of these relationships can be varied, as can the abstractness of the terminology used to describe the organisms. The commands and activities available to the child are determined by the systems knowledge base.

At present Ecolab has a strong student model, quantifying help used in combination with the difficulty of tasks tackled. The software has concentrated on the domain level of scaffolding the learner and largely ignored metacognitive issues. Metacognition can be broadly referred to as any knowledge or cognitive process that refers to, monitors, or controls any aspect of cognition. Flavell [3] distinguishes between metacognitive knowledge and metacognitive regulation. Metacognitive knowledge refers to information about ones cognitive processes and is subdivided further into knowledge of person, task and strategies. Metacognitive regulation incorporates a variety of executive functions and metacognitive strategies such as planning, resource allocation, monitoring, checking and error detection and correction [4]. Metacognition plays a role in enhancing cognitive performance including attention, problem solving and intelligence with implications to areas like education [5]. Studying metacognition provides an insight into the cognitive processes involved in learning and can indicate what differentiates successful students from their less able peers. Successful students continually evaluate, plan and regulate their progress, which makes them aware of their own learning. When confronted with an effortful cognitive task some individuals are more metacognitive than others are and it is those with greater metacognitive abilities that tend to be more successful [6].

Data from metacognitive-training research has shown that students do well when explicitly prompted but often fail to adopt useful control strategies spontaneously in new circumstances. Our aim is to create an environment that provides metacognitive support around the goal of helping students to learn about ecology. The development of meta-level scaffolding support has the potential for generalisation across knowledge domains and learner age range, as it will not be exclusive to the particular domain of implementation. Primarily our metacognitive concerns focus on how executive control processes are related to help-seeking and task selection activities. Types of executive control include predicting such things as how difficult a particular learning task is (task selection), planning what will be done during the learning task and selecting appropriate strategies (help-seeking), monitoring the learning process and evaluating the results of these activities to inform future learning.

Previous work by Luckin [7] and Wood [8] has shown that less able learners are often unaware of their own learning needs and are ineffective at making selections of activities and assistance. The initial Ecolab study showed that more able learners responded positively to suggestions from the system about what they should learn next, how difficult it should be and how much support they should accept from the system. It also provided evidence of the large variance in learner self awareness and help-seeking ability. Introducing metacognitive scaffolding within software, by making learners aware of how much the activities that they select are challenging their abilities and how they use the support available, should enable them to be more effective at utilising software scaffolding at the domain level and progress further as a result.

In order to design a metacognitive scaffolding framework that can be incorporated into the design of educational software we aim to develop an understanding of how learners might be scaffolded at the metacognitive level. More specifically, in this paper we will be investigating how learners' ability to challenge their own skill level and seek appropriate assistance might be supported through exploring their perceptions of, and attitudes towards challenge and help.

EARLY STUDIES

Working with children can be difficult because they are generally less able to express their thoughts and ideas. It is also hard to gauge how the tasks planned might work and whether the children will fully understand what it is that they are required to do. Hence, all the studies that have been carried out have been exploratory in nature and involve small numbers of children. We need to find the appropriate language to use when talking to them about help as well as their views about challenge and help itself.

Initially we concentrated on investigating children's attitudes towards help and challenge: What do they perceive as helpful and challenging? The children were presented with two ecology tasks and a game to play. One of the tasks involved providing the children with statements about what animals in a food chain ate. For example - *Jays eat bumblebees; Bumblebees eat foxgloves.* From this information the children were asked to build a food chain using arrows and labelled pictures of the organisms. The length of the food chains and the organisms used varied. The food chain tasks were followed by a food web task. This time the children were presented with a set of food chains and statements about what animals in the food chains ate. The children had to use the statements to add arrows to the food chains to produce a food web.

In general, the children preferred to choose the task that they perceived to be the easiest to do first. However the reasons for one task being easier than another varied. Some of the children perceived a task to be easier because of the organisms used in the task.

The game involved two teams, which took it in turns to challenge the other team to complete a food chain task or a puzzle (based on food webs). The team members were chosen at random to do a challenge and were allowed one form of help from a choice of 3 (ask a team member, ask for a hint, and ask anyone) for each new challenge.

"Because you know owls, well you know owls eat mouses and things, and they eat flowers and things"

Other children focused on the size of the food chains, looking at the sentences that describe the eating behaviour…

Easier: "Because it has got less writing"
Harder: "Because it has got 3 instead of 2"

…Or the size of the diagram…

"Because it is smaller and easier"

…Or the number of pictures.

Harder: "Because there is more on this side than that side"

Not all the children opted for the task that they perceived as easier, a few of the children preferred to do a more difficult task first.

"The hardest one…the hardest one gives you more of a challenge"

When questioned about help the children appeared to find it difficult to suggest how they would help their peers.

Experimenter: "How would you help them to make it easier?"
Child a: "Read this…I don't know."

Child b: "Read it out…Do the pictures in order and instead of doing the arrows the right way, turn them around."

We also wanted to initiate a dialogue with the children about designing software so we took the opportunity to open up a discussion about this too. When the game playing finished the children were told that the reason for playing the games was because they were to going to help design a computer game to learn about ecology. This was followed by several questions about their opinions of computers to discover their views about making the games that they had played into a computer game.

When talking about designing something for the computer all the children thought that it was important to design a game because it helped to make the subject interesting. They also shared the idea of having a game with different levels, getting harder as you progress up a level. When asking the children to come up with their own design their ideas appeared to be constrained by either the previous tasks or commercial computer games available. We realised that we would need to find a more effective way of motivating this dialogue and plan to implement some example interfaces and interactions as a focus for further discussion. However, the children's designs highlight the need to make the game fun and provide ideas to work from.

These early exploratory studies were designed to gather information about children's first choice of task to tackle by offering a range of possibilities (different sized food chains and food webs) to the children. The children's ability to seek help was investigated by looking at what point they would ask for help and their preferred form of help. The sessions produced interesting data about challenge and help seeking behaviour. However, in some situations it was apparent that the children were sometimes unable to express their thoughts about when they would choose to use help, the types of help that they found useful and why they would choose a particular task or challenge.

WIZARD OF OZ

The early studies showed that the children had some valuable contributions to make but the tasks and the game that they were given was not necessarily the best way to elicit information from the children. An adaptation of the 'Wizard of Oz' technique [9] was therefore adopted to examine the issues of help and challenge further. The 'Wizard of Oz' technique is commonly used to simulate human computer interfaces. The wizard's existence is usually unknown to the user, but he or she is responsible for making decisions about how the system will respond to the user's actions. It is a useful technique for evaluating potential alternative interfaces or functionality without the need to implement these alternatives within the system under development. In the adaptation of this technique for our studies, children worked in pairs. One child adopted the role of the computer and the other adopted the role of a user of that computer. The child user knew that the wizard existed. In fact, both user and wizard worked on the same apparatus and could view each other's interactions continuously. The interfaces and functionality were not implemented in software. The interfaces were paper based and the child taking the role of the computer provided the functionality by operating what was, in effect, a paper computer.

Method

Participants. Eighteen children aged from 9 to 11 years old attending a local primary school (5 – 11 years old) were divided into pairs. All the children were members of the same class and were paired with someone that they felt comfortable working with.

Procedure. The children were shown the 3 different 'computer screens' and were told that they each represented a different view of an ecology game. The game was designed to be similar to an ecology laboratory, which presents an environment into which different arctic organisms can be placed and the relationships that exist between them explored. They were told how to use the screens and were shown some examples of what could be done.

The children were told that one of them had to pretend to be a ‘computer’ and the other had to pretend to be a ‘user’ of the computer. The ‘computer’ (child) was told that they would have to choose a challenge for the user to complete and if the ‘user’ found the challenge hard the ‘computer’ (child) could give clues to help. They were given details of how animals acquired their energy, rules about changes in energy values and answers to the challenges. The role of the ‘computer’ (child) also included updating the 3 screens when the ‘user’ added organisms to the Ecolab and performed actions via the command board. The ‘user’ was told that they had a challenge to do and that they could use the ‘Ecolab’ to complete their challenge.

The children were recorded using a video camera so that their actions and speech could be transcribed for analysis.

Materials. The setting for the ecological habitat was the arctic and 9 different arctic animals and plants were used. Three different mock up computer screens made from cardboard were used to view different ways of representing the organisms. All the screens were based on the interfaces from the original ‘Ecolab’ software. Screen 1 was labelled ‘World View’ and was used to show the organisms that had been added to the environment. Screen 2 was labelled ‘Web View’ and was used to show the organisms appropriately positioned in a food web when they were added to the environment. Screen 3 was labelled ‘Energy View’ and was used to show the energy values of all the organisms in the environment. All 3 screens were visible throughout the study and the layout of all the materials can be seen in Figure 1 with video still representations in figures 2 and 3.

The ‘user’ had a paper representation of each organism in the form of a piece of paper with the organism’s name on it. They could use these to add the organism to the ‘Ecolab’ by placing it on the world view. The ‘user’ also had a command board on which they could place the names of organisms to perform actions within the ‘Ecolab’.

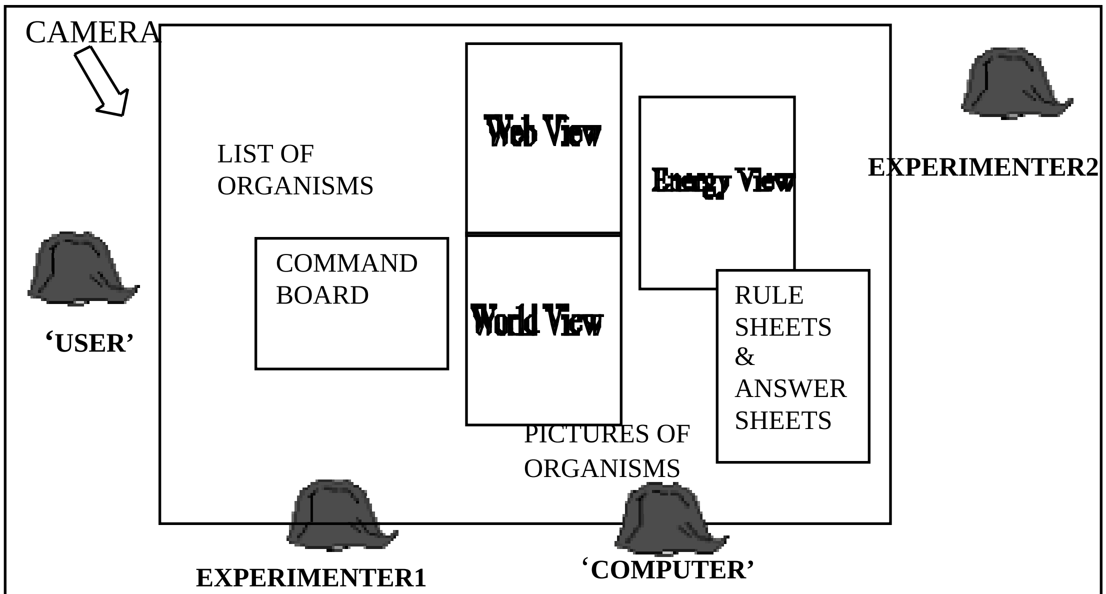

Figure 1 – Diagrammatic representation of the layout of materials.

Figure 2 - Video still from Wizard of Oz experiment

Figure 3 - Video still from Wizard of Oz experiment

The ‘computer’ (child) had 2 pictures of all of the organisms that they placed on the world view and the web view when the ‘user’ added them to the environment. The ‘computer’ (child) had a pile of arrows that they could add to the web view to create food chains and food webs when the game dictated this. For each organism the ‘computer’ (child) also had units of energy (from 1 to 4 units) to place on the energy view to implement an organism’s energy change and a description of what the organism got their energy from.

There were 3 different types of challenge each with 3 different levels of challenge:

1. Animals and their food
2. Energy transfer

3. Predators and prey

The challenges were adapted from the original 'Ecolab' software for the arctic environment and for use in the context of the game.

Results

The transcription is helpful in ascertaining the levels of help that the children perceived to be useful. Sometimes the children tried to help the 'user' as best they could where as other times they chose to make it difficult. When the children playing the role of the computer were asked to select an appropriate task from those available they did not appear to identify the differences in the levels of challenge in the tasks. We need to explain these perceptions of challenge and intend to do so in our future empirical studies. The children's comments also highlighted their views about the capabilities and limitations of a computer. The extracts from the transcripts below show some examples of the kinds of responses that the children made to the requests for help.

Task: The 'user' is trying to explore if everything can be either eaten or eat.
User: "I am not sure what to do"
Computer: "If you press them it will tell you what they eat."

The task given to the 'user' was more exploratory than previous tasks and the 'user' was finding it hard to get started. The 'computer' provides enough help to the user to begin the task without explicit detail. The feedback they produce is focused on the features of the system: if they 'press' an animal with their finger the 'computer' will tell them what that animal etas and what it is eaten by.

Task: The 'user' is answering questions at the end of a challenge.
Experimenter: "OK so are you going to tell him he's wrong or are you going to help him this time?"
Computer: "No I am going to tell him he is wrong."

In this example the computer provides very little feedback to the user and they don't know where they have gone wrong.

Task: The 'user' is trying to find out which animals are prey and has chosen Insect, Fish, Wild flower so far.
Computer: "I would say you've got the wild flower in the wrong place"

This is an example of help given by the computer, telling the user where they have gone wrong but not providing a clue as to how the user might get the correct answer.

Task: The 'user' is trying to find out which is prey from 5 remaining organisms
Computer: "I would say that, I would give him a clue like it lives in the sea or something…Because there are more animals that live in the sea…So it would not be totally given away."

A descriptive clue is given to the user about what they are looking for which is related to the type of organism that they need to find rather than a clue about how they might work out how to find the answer.

Task: The 'computer' is choosing the task for the 'user'
Experimenter: "Why did you choose that one?"
Computer: "It is the hardest…and computers are really mean"

The computer has chosen the task that they perceive to be the hardest because of the way they view computers.

Help Selection

Adapting the 'Wizard of Oz' technique [9] enabled the children to start to verbalise their thoughts and opinions about help seeking and task selection. However, the children did find it difficult to think of clues to help the 'user' and the amount of help that the children could provide was limited by this. To continue to abstract information about children's perception of help it needed to be examined in isolation. Focusing on help and minimising the tasks that the children have to do should reduce their cognitive load and provide more resources to concentrate on the issue of help.

Method

Participants. 7 children who took part in the first 'Wizard of Oz' study were chosen at random. Previous experience of the 'Wizard of Oz' study was essential due to time constraints and a prior understanding of how to use the screens that were implemented in the system. The children took part individually.

Procedure. The study was separated into 2 parts. The first part required the child to use a computer version of the game that they had played in the first 'Wizard of Oz' experiment. They were told that this was called the 'Ecolab' (It was a first prototype for the next version of the original the 'Ecolab' developed by Luckin [7]). At the beginning of the session the child was shown how the system worked, including how to use the different functions and to view the different representations. They were also given a list of keywords of ecological terminology and written details about how to use the prototype, which they could refer to at all times. The child was given 5 tasks to do using the system. These required them to use all of the implemented functions at least once.

In the second part of the study the child was given the scenario of helping a friend in their class by giving them a clue to a problem with which their friend was having difficulty. They were read the problem, followed by the answer and were then asked if they could think of a clue that may help their friend with the answer. It was explained that the clue did not have to give away the answer; their clue could contain as little or as much help as they wanted to give. They were then given 6 different examples of possible clues related to the problem in hand. These included their own clue. They were then asked which one they would like to choose to give. They were asked why they had chosen a particular clue and asked to rate the clue that they had chosen on a 5 point Likert scale of helpfulness (1 not very helpful will need another clue – 5 very helpful will get answer). The children were recorded using a video camera so that their actions and speech could be transcribed for analysis.

Materials. The functions and screens previously used in the 'Wizard of Oz' experiments were programmed using Java to represent a computer version of the game that the children had played previously. The children had 5 tasks to do using the computer.

For the second part of the study the children had 5 different problems, each with the answer written underneath. For each problem they had 6 different clues to choose from and a helpfulness rating sheet to rate the clues. The first clue was always their own clue and the other 5 were produced following the 5 levels of control from the contingent teaching strategy developed by Wood et al [10] and adapted by Luckin in the original version of the Ecolab.

Results

The dialogue between the students and the experimenter has been transcribed and are being coded into categories using Nudist™. The categories used have been carefully selected and were informed by observations from our earlier studies and the questions we wanted to explore in this study. With respect to help provisions and help seeking, these categories enable us to:

1. Differentiate the times when learners are focusing on procedural or operational issues from the times when they are involved in the practicalities of answer construction to the tasks given to them in the first part of the study, and
2. To differentiate the times when they are trying to construct an understanding of a problem to provide a clue.

In order to investigate the children's ability to provide and seek help we developed an index tree, which enabled us to categorise the type of dialogue. This meant, for example, that we could see what learners were talking about when they were completing a task on the 'Ecolab' or rating a clue in helpfulness.

The dialogue was categorised initially into *provision, request, rating, mode preference, talk, action, surprise, thinking*, each of these categories has then been sub-divided for a more detailed analysis.

3. PROVISION – This includes dialogue where the speaker is providing information and includes sub-categories of *help, task, fact, feedback, clue, apology, answer, and justification.* Again some of these are sub-divided for more detail.
4. REQUEST - This includes dialogue where the speaker is requesting information and is broken down into the same categories as those used in the provision node.
5. RATING – This category contains dialogue related to the rating of a chosen clue.
6. MODE PREFERENCE – This consists of dialogue about the mode of help given on a computer. For example, whether help should be audio or visual or both.
7. TALK – This category includes all the talk throughout the discussions and distinguishes between the levels of talk. The sub-categories are of particular interest to the investigation of metacognitive scaffolding as they consist of system-level, domain-level, and meta-level talk.
8. ACTION – This category encompasses dialogue about any actions that are being made or about to be performed.
9. SURPRISE – This contains dialogue that relates to comments of surprise.
10. THINKING – This encompasses talk in which the speaker is thinking aloud.

The transcript is still being coded and continues to be analysed with a particular focus on dialogue that provides information about how to make help available to students and when they seek help. Interesting comments have been noted and some of these are given in this section as examples of the dialogue.

The study has allowed us to explore both children's help seeking behaviour and their attitude towards help provision, as well as their beliefs about what sorts of clues are most helpful. All of this information will prove invaluable in the development of metacognitive software scaffolds. The first part of the study provided information about children's ability to seek help. The two samples of transcript below highlight the differences in help seeking behaviour between children. In the first example the child actively seeks help as soon as they are unsure about what to do next.

Task: The child is investigating what happens to the caterpillar's energy level when it moves. They have added the caterpillar and have just changed from world view to web view.

Experimenter: "So that is the caterpillar there it has 2 units"
Child: "Ok so what shall I do?"

In the second example the child is having difficulty completing the task and needs to be prompted into asking for help.

Task: The child is investigating what happens to the sparrow hawks energy level when it eats. The child is in the world view and contains the sparrow hawk. The thrush has just been added.
Child: "Um…"
Action: *Child clicks on thrush*
Experimenter: "I am a thrush and I eat snails. If you want some help or anything just ask me if you are stuck on anything."
Child: "I want some help."

The second part of the study focused on children's attitudes towards help provision and their beliefs about what sorts of clues are actually the most helpful. The children were asked to provide a clue of their own before being shown a further selection of clues. The rationale behind this was to see what kind of clues the children produced and their reasoning behind the clue's helpfulness. When provided with the answer directly after being given a specific problem some of the children appeared to be able to provide clues more easily than with the 'Wizard of Oz' study. However, not all of the children were able to think of a clue for every problem presented to them. Thus, the choice of clues still provided an opportunity for evaluation of helpfulness. Overall, the children gave detailed explanations about why they had chosen a particular clue and how much they thought it would help.

The way a student perceives another student's need for help may not reflect how they perceive their own need for help or their preferences for their own help provision. Examples of this were also reflected in the transcripts. One child provided a clue that gave the whole answer to every problem. However, when asked later on about their own preference for help provision they discussed a desire not to be given the whole answer straight away.

Child: "That would just be giving it away again."
Experimenter: "OK. You don't have to give them the complete answer if you don't want to."
Child: "Yeah I know."
…
Experimenter: "When you get help would you prefer to have something that will give you the answer or something that should give you the answer as opposed to …"
Child: "I like a little task if you know what I mean but I try to work it out as hard as I can then if that doesn't work I usually ask someone so I should get the answer."

Other children were not consistent in the level of helpfulness in their help provision. Below is an example of a child justifying 2 of their choice of clues.

Child justifying help chosen after rating it 4 in helpfulness: It is helpful we need energy to live and it gives you the answer.
Child justifying help chosen after rating it 2 in helpfulness: It gives you a clue but doesn't give you the answer.

The differences in the level of help chosen by a child could be related to the content of the current problem and the child's own understanding of that problem. If a problem is perceived as relatively easy, a child may think that most clues are helpful. However, is a problem is perceived to be more difficult they might perceive the same type of clues as being less helpful.

As yet we have not taken into consideration the children's intelligence or understanding of the tasks involved. These factors may have some influence on the ability of a child to produce a clue that they think is suitable for one of their peers as well as influencing the type of clue that they would choose to give. After analysing the clues provided by the children it is clear that some miss-understood the context in which they were to provide a clue. For example for the problem *Sarah has selected the eat action and has put the caterpillar as the eater and the thistle as the eaten. But in this case caterpillars do not eat thistles. Caterpillars eat rose leaves and thistles are eaten by slugs*. The situation described in the problem above is similar to a task that the children had to perform in the first part of the study. All the children were asked if they understood this problem. Some of the children provided clues that were unrelated to the Ecolab.

"Think where caterpillars live, think about the plants"

"Because I think that thistles are bigger than caterpillars. And caterpillar wouldn't eat anything that was like that, that was bigger than themselves."

Other children included the use of the Ecolab in their clues.

"You can look on that, on the Ecolab."
"Caterpillars eat rose leaves and slugs eat thistles."
"Use the action and eat command to see what things eat."

Encouragement plays a big part in classroom teaching. The need for some form of support that inspires confidence within educational software was highlighted by one of the children in the study.

" Because they are all like not very helpful… And they are all not confident, you should try and make the person like confident in what you say."

The samples of transcript above show examples of what we have found. We are continuing our analysis and hope to present more detailed results at the workshop.

CONCLUSION

This paper has outlined the direction of our research and highlighted the difficulty of getting children to communicate their attitudes and beliefs. By continuing to narrow the focus of our studies we have been able to gather increasingly detailed information about what children think is helpful and the reasons behind their choices of help. Differences between a child's own preference of help and their provision of help have been observed. Further analysis of the data is needed to develop future studies in which help seeking can be re-examined and task selection can be investigated in finer detail.

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REFERENCES

1. Hammerton, L.S. and R. Luckin. *You be the computer and I'll be the learner: Using the 'Wizard of Oz' technique to involve children in the software design process*. In proceedings of *Artificial Intelligence in Education*. 2001. San Antonio, Texas USA.
2. Rosson, M.B. and J.M. Carroll, *Scaffolded examples for learning object-oriented design.* Communications of the ACM, 1996. 39(4): p. 46-47.
3. Flavell, J.H., *Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry*. American Psychologist, 1979. 34: p. 906 - 911.
4. Brown, A.L., et al., *Learning, Remembering, and Understanding.* In *Handbook of Child Psychology*, J.H. Flavell and E.M. Markman, Editors. 1983, Wiley: New York. p. 77 - 166.
5. Bruner, J. *Celebrating Divergence: Piaget and Vygotsky*. in *Growing Mind Conference*. 1996. Geneva, 15 September.
6. Livingston, J.A., *Metacognition: An Overview*. 1997.
7. Luckin, R., *'ECOLAB': Explorations in the Zone of Proximal Development.* 1998, School of Cognitive and Computing Sciences, University of Sussex.
8. Wood, H.A. and D. Wood, *Help seeking, learning and contingent tutoring.* Computers and Education, 1999. 33 (2-3): p. 153 - 169.
9. Dahlback, N., A. Jonasson, and L. Ahrenberg, *Wizard of Oz studies - Why and How.* Knowledge-Based Systems, 1993. 6: p. 258 266.
10. Wood, D.J., H.A. Wood, and D.J. Middleton, *An experimental evaluation of four face-to-face teaching strategies.* International Journal of Behavioural Development, 1978. 1: p. 131-147.