Computer Science Students' Self Directed Learning Skills During a Creative Design Project

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The following table is based on qualitative thematic analysis of learning logs written by 113 first and second year computer science students during a twelve week creative design project. I have focussed on self directed learning skills under the main headings of planning, evaluating and help seeking. For each sub-skill within these categories, I have attempted to identify the hallmarks of effective and less effective learners. Not all effective self directed learners display all of these skills, and nor do all less effective learners suffer from all of these difficulties. Nonetheless, these markers may be a guide for other educators when diagnosing their students' self directed learning skills. There are likely to be gaps in the skills or difficulties identified here as they are based on evidence from one particular class in the computer science domain. Educators working in different subjects or at a different level may have different experiences. I have also provided some initial advice for educators to help their less effective students improve in this area, but I am naturally open to other suggestions.

Skill	Sub-skill	More effective learners…	Less effective learners …	Advice for educators
Planning	Generating own goals	Playfully explore the possibilities offered by the learning environment. Devise mini-projects to learn skills. Extend lab exercises. Set own challenges if module is too easy.	Don't set their own goals in the early stages of learning a new environment. Stick to tasks and materials from staff. Note the module is too easy but don't take responsibility for setting themselves harder tasks.	Explain to learners that learning through exploration can be valuable. Encourage able learners who seem bored to challenge themselves.
Planning	Generating and selecting ideas	Try to set the challenge of an idea according to their abilities. Consider multiple ideas. Analyse the difficulty of the idea in some detail before committing.	Lack self efficacy. Don't investigate the feasibility of ideas before selection. Overestimate their ability and choose an idea which is too hard. Underestimate their ability and	Discuss plans with students to advise on how difficult an idea will be to implement. Divert students from dead ends before they invest too much effort. Encourage less confident but able students to be more ambitious.

		Defer decision making until they can estimate their abilities more accurately. Are flexible about adapting or scaling back ideas if necessary. Can judge when to stop pursuing a dead end.	choose an idea which is too easy.	Encourage students to think of several alternatives. Help students deal with frustration. Celebrate creative ideas.
Planning	Planning learning	Plan what to work on next after each session. Make lists of items to research or problems to fix. Plan learning strategy. Are able to re-plan and choose another method if the original method fails. Decide to take risks. Decide to aim high. Decide to invest effort. Consider development process as a whole.	Decide to minimise effort. Get stuck if the first method they try fails.	Encourage learners to finish each session with a plan for next steps. Discuss with students alternative methods they could use if one fails. Reward effort
Planning	Task management	Split tasks into subtasks with manageable deadlines. Set themselves deadlines from early in the project. Work iteratively on multiple "drafts" – increase standards at each iteration. Recognise when a general framework could help subparts of the solution. Recognise task	Only use external deadlines rather than setting their own interim deadlines. Make vague plans, or none at all. Make unrealistic plans.	Encourage learners to set deadlines for themselves throughout the module. Help them to identify task dependencies. Encourage them to consider using an iterative development methodology.

		dependencies.		
Evaluating	Evaluating own performance	Evaluate their progress regularly. Look back on progress over a few weeks. Recognise that skills require effort and practice to develop. Analyse in some detail which skills they have mastered and which need more work. Consider possible reasons for perceived poor progress. Evaluate whether their current strategy is working. Assess their level of understanding and what activities increase understanding.	Worry about being stupid. Lack metacognitive knowledge about the task domain (such as about the nature of problem solving). Judge themselves harshly even if external evidence suggests they are doing well.	Scaffold evaluation skills by self and peer assessment exercises. Encourage and model regular reflection. Advise students to focus on solutions to lack of progress rather than dwelling on failures. Persuade students that it is acceptable to acknowledge when one has done well. Make it clear that there is a distinction between ability and experience; practice and effort will pay off even for students who start off with no prior knowledge. Remind learners that other people have difficulty with the material too. Reiterate that practice makes perfect.
Evaluating	Evaluating own product	Evaluate product so far critically in some detail. Evaluate engineering process as well as product. Decide whether an idea is good enough. Decide whether and how to take advice from a peer. If appropriate stand by own idea instead of taking peer advice.	Find it hard to judge the quality of their product. Are unduly critical of their own work. Do not reflect in detail on their learning – can be vague.	Model evaluation of product by publically identifying good aspects of student work. Encourage learners to be patient with the quality of their product until their skills increase. Help learners to decide which aspects of peer advice are feasible within the time limit. Encourage learners to take pride in the quality of their engineering as well

		Can reflect honestly on what they have learned during a module and how they could have done better.		as the appearance or functionality. Reassure learners that it is acceptable to stick with one’s original ideas instead of taking peer review suggestions on board all of the time.
Evaluating	Evaluating/ predicting task difficulty	Can accurately estimate how difficult a task will be. Can evaluate which parts of a task were most challenging after completing it. Regularly compare expectations of difficulty to actual difficulty. Recognise that effort is a predictor of task success.	Are pessimistic about task difficulty. Are optimistic about task difficulty. Assume that something will be too hard, and so don’t attempt it.	Suggest that learners compare expected to actual task difficulty to remind them that they are capable of mastering difficult material and also help them predict more realistically in future.
Evaluating	Monitoring	Know when to stop using a strategy if it isn’t working. Set time limits on exploring a solution to prevent dead ends. Recognise that some tasks are hard to estimate. Direct more time and effort into the project when it is going badly.	Drop standards rather than increase effort when progress is poor. Panic and work in a non-productive pattern (such as all night).	Discuss effective working practices with the class. Identify at-risk students and help them re-plan their project before it goes too badly wrong.
Evaluating	Evaluating learning environment	Predict problems arising from constraints of learning environment, and plan around them. Evaluate challenges inherent to learning environment or	Blame the learning environment rather than their effort for lack of progress. Are critical of the learning environment without thinking through why it has particular	Acknowledge limitations with learning environment, but help the students find work arounds. Explain to learners why constraints or limitations exist.

		activity. Compare learning environment to previous learning environments. Learn how to work within constraints of learning environment.	constraints.	
Help seeking	From staff	Ask for help before a problem becomes a major hindrance. Discuss ideas as well as problems with staff. Are aware there is satisfaction in solving one's own problems.	Avoid asking staff for help because they worry abut being judged negatively, or because they fear becoming too dependent.	Reassure students that it is acceptable to ask for help when necessary. Advertise office hours or other time when staff are free to discuss projects.
Help seeking	From peers	Work with other students to solve problems. Ask more able peers for help. Ask advice and feedback from peers. Give as well as receive peer support.	Use other students' solutions without critical thought. Avoid working with peers Behave in a non-supportive way towards peers. Show off their knowledge in a way which makes other students feel inadequate.	Facilitate a supportive learning environment where students are expected to give and receive peer support. Model constructive feedback skills. Moderate "strutting" behaviour from more able students so less able students do not get demoralised.