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Professional Development Service for Teachers | An tSeirbhís um Fhorbairt Ghairmiúil do Mhúinteoirí

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LEAVING CERTIFICATE COMPUTER SCIENCE

Leaving Certificate Computer Science

National Workshop 1

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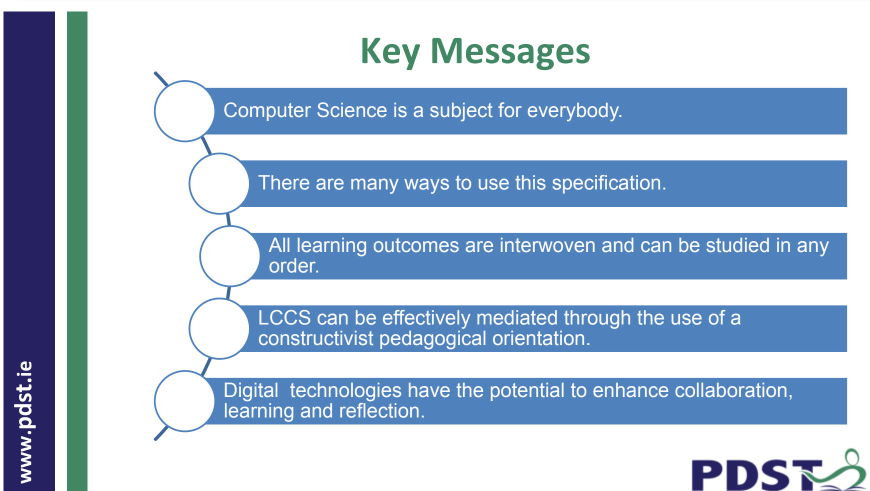
Table of Contents

Session 1



Notes

Culture and Expectations

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Teachers are the Key

Leader & Champion

Privileged Place

Bring Different Experiences

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Mentimeter

Questions - What should the culture be in the group not just for this National Workshop but going forward over the next two years?

What expectations do you have from each other?

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Notes

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Mentimeter

- URL = www.menti.com
- Code = 98 0571

PDST

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The Role of the PDST

PDST

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What we are not

- Evaluators
- Policy makers
- Curriculum developers

What we are

- Teachers & school leaders
- Teacher Educators
- Facilitators / Enablers
- Purveyors of lifelong learning

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Notes

Growth Mindset

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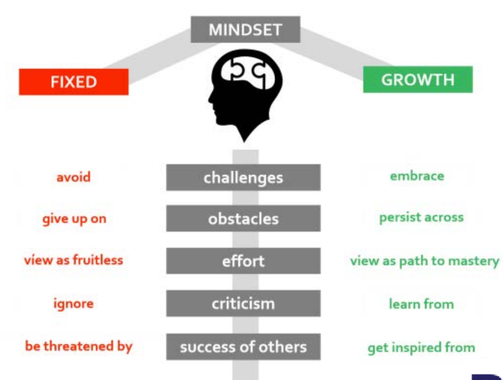
Growth Mindset



Notes

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CS For All

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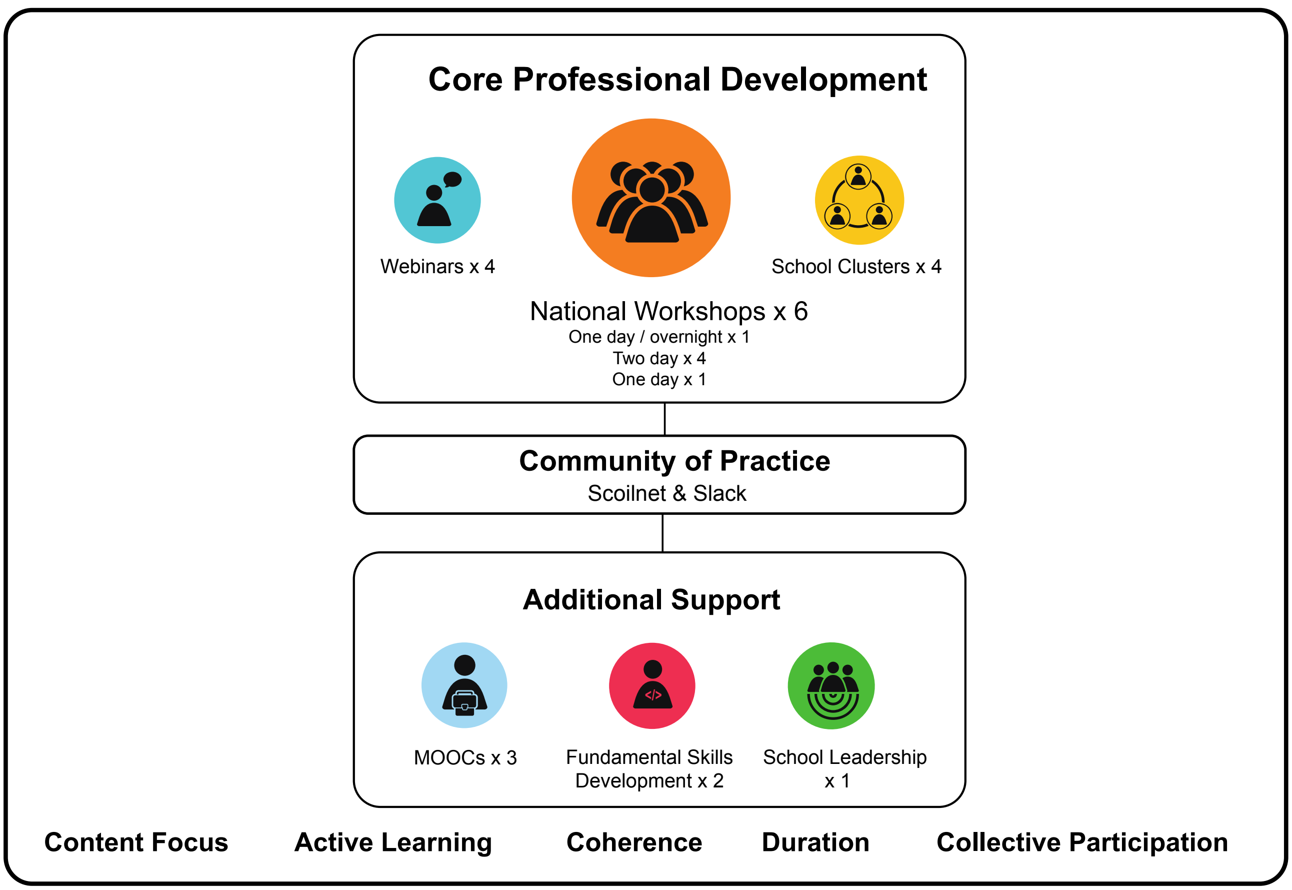
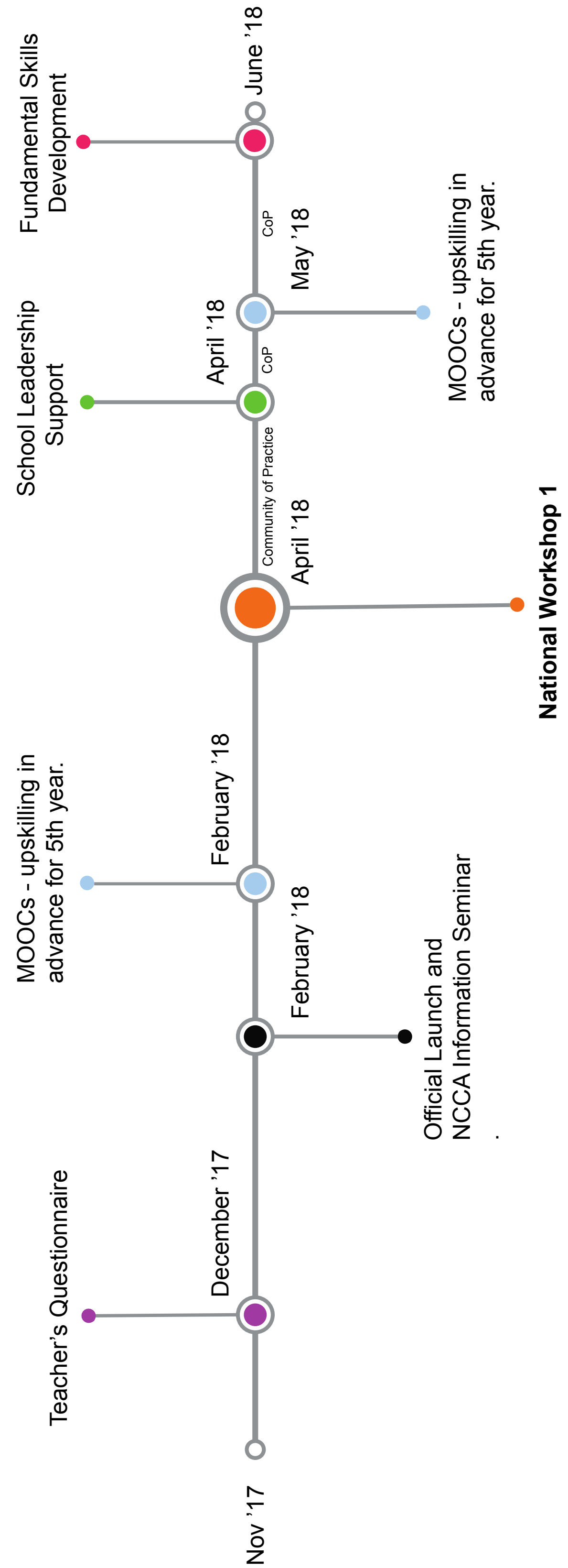
Fusion CPD Framework

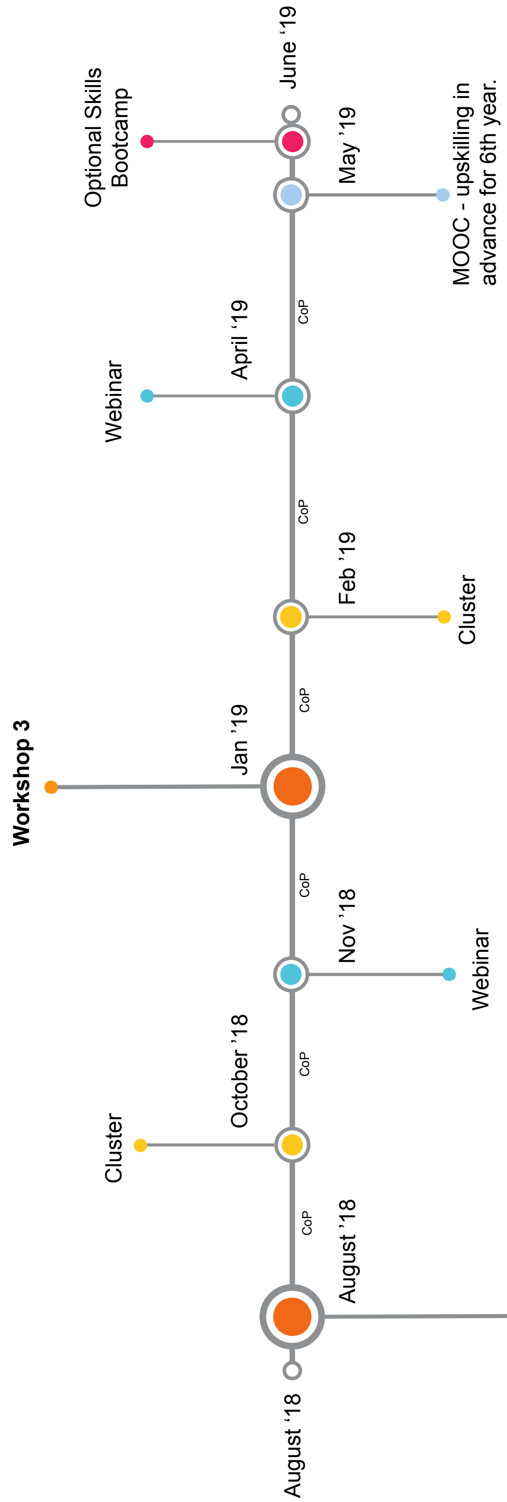
Overview of Framework



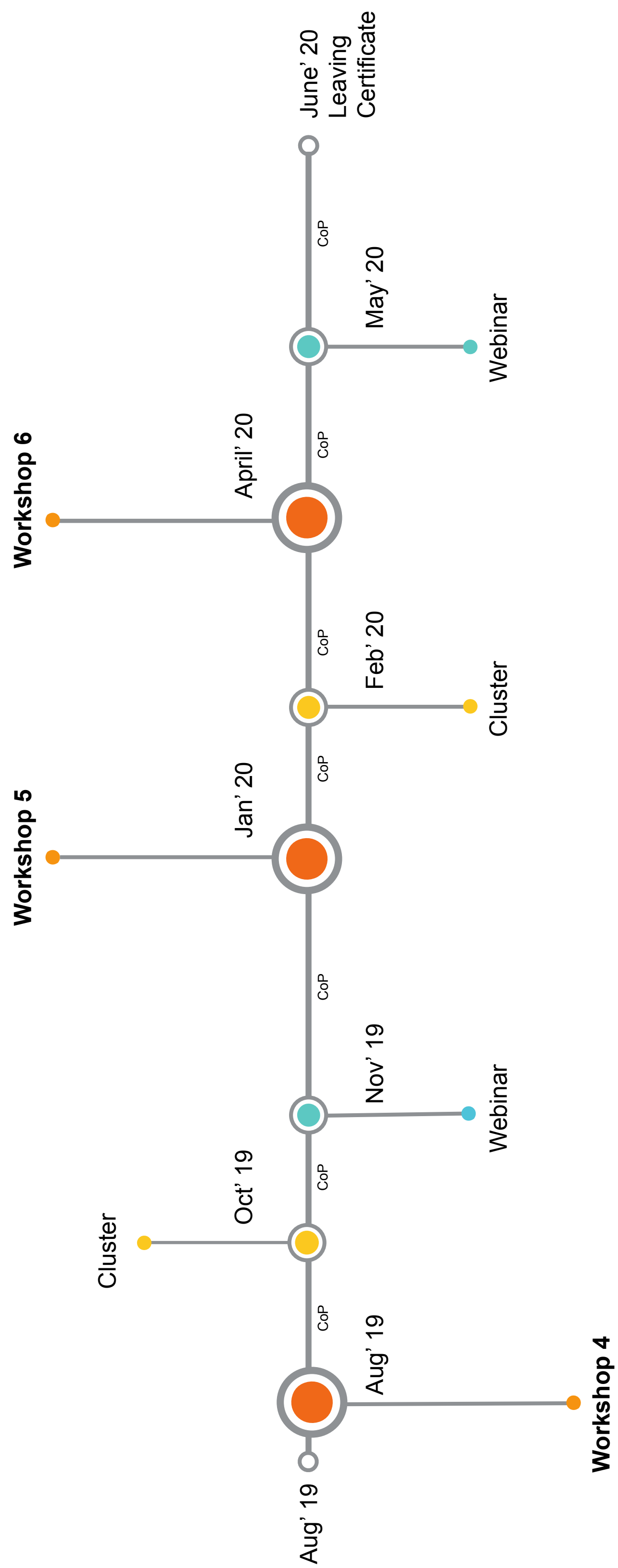
Framework Details



Timeline - Round 0



Timeline - Round 1 - 5th Year



Timeline - Round 2 - 6th Year

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Dates for your Diary for 2018

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National Workshop 1	Monday 30th April & Tuesday 01st May 2018
School Leadership Support (Principals)	Wednesday 9th May 2018
MOOC II released (online)	Wednesday 16th May 2018
Skills Development	Wednesday 23th, Thursday 24th & Friday 25th May 2018 (Cohort 1) Monday 28th, Tuesday 29th & Wednesday 30th May 2018 (Cohort 2)
National Workshop 2	Thursday 6th September & Friday 7th September 2018 (Cohort 2) Monday 10th September & Tuesday 11th September 2018 (Cohort 1)
Cluster 1 Meetup	October - details will be given out at National Workshop 2.
Webinar (online)	November - details will be given out at National Workshop 2.

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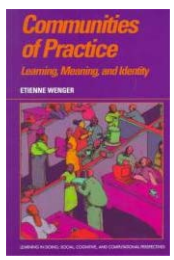
Community of Practice

Notes



'Groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly'

'Engage in a process of collective learning in a shared domain of human endeavor'

- Etienne Wenger

Notes

LCCS Community of Practice

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Leaving Certificate Computer Science Curriculum Specification

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5 Key Skills at Senior Cycle

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LCCS Strands

Strand 1: Practices and principles	Strand 2: Core concepts	Strand 3: Computer science in practice
• Computers and society • Computational thinking • Design and development	• Abstraction • Algorithms • Computer systems • Data • Evaluation/Testing	• Applied learning task 1 - Interactive information systems • Applied learning task 2 - Analytics • Applied learning task 3 - Modelling and simulation • Applied learning task 4 - Embedded systems

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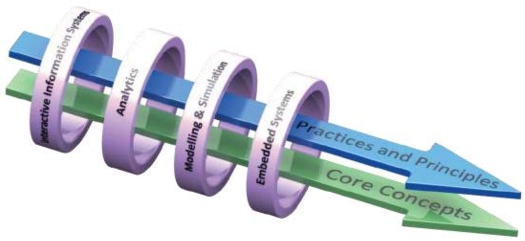
LCCS Interwoven



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LCCS Assessment

Component	Percentage
End-of-course examination ‣ Computer-based assessment of learning outcomes	70
Coursework assessment ‣ One computational artefact with report	30
Total	100

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Question Board

slack

Workspace = pdstcs

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Notes

List of 40 Phase 1 Schools

School Name	Address
Abbey Vocational School	The Glebe, Donegal Town, Co. Donegal
Adamstown Community College	Station Rd, Adamstown, Co. Dublin
Breifne College	Cootehill Rd, Cavan, Co. Cavan
Bush Post Primary	Riverstown, Dundalk, Co. Louth
Carrigaline Community School	Waterpark, Carrigaline, Co. Cork
Castleblayney College	Dublin Road, Castleblayney, Co. Monaghan
Christ King Girls Secondary School	Half Moon Lane, South Douglas Road, Cork
Clongowes Wood College	Clane, Co. Kildare
Coláiste an Chraoibhin	Duntaheen Road, Fermoy, Co. Cork
Coláiste Bríde	New Road, Clondalkin, Dublin 22
Coláiste Chiaráin	Croom, Co. Limerick
Coláiste Choilm	Ballincollig, Co. Cork
Coláiste Mhuire	Mullingar, Co. Westmeath
Coláiste na Ríochta	Listowel, Co. Kerry
Colaiste Phadraig	Roselawn, Lucan, Co. Dublin
Coláiste Pobail Setanta	Phibblestown CC, Phibblestown, Dublin 15
Creagh College	Carnew Road, Gorey, Co. Wexford
Dominican College Sion Hill	Sion Hill, Blackrock, Co Dublin
Ennistymon Vocational School	Ennistymon, Ennis, Co. Clare
Gaelcholaiste Mhuire AG	An Mhainistir Thuaidh, Corcaigh
Le Chéile Secondary School	Hollystown Road, Tyrellstown, Dublin 15
Loreto College	Swords, Co. Dublin
Luttrellstown Community College	Mill Road, Blanchardstown, Dublin 15
Mayfield Community School	Old Youghal Road, Mayfield, Cork
Moate Community School	Church Street, Moate, Co. Westmeath
Mount Sion CBS	Barrack Street, Waterford

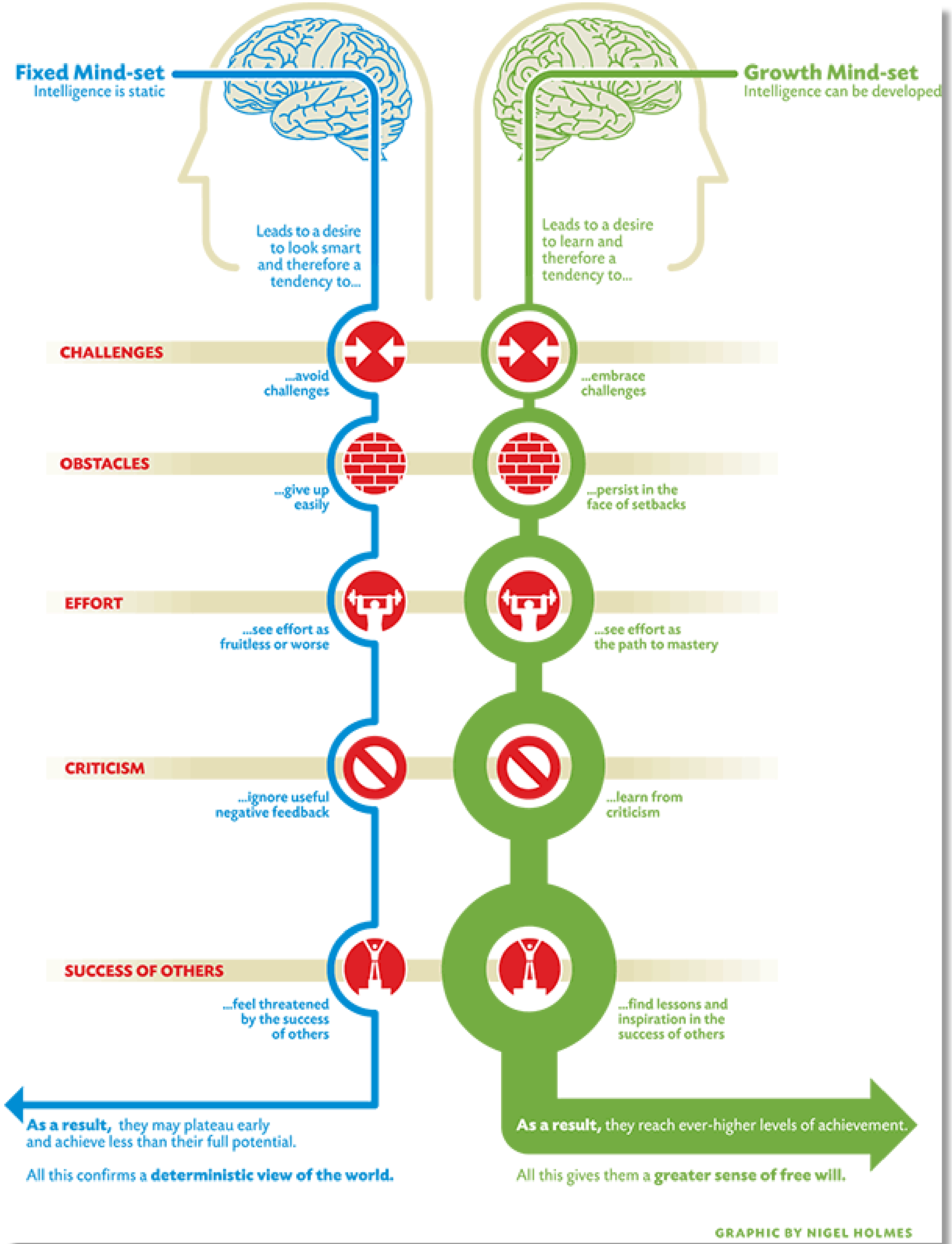
Mount Temple Comprehensive	Malahide Road, Dublin 3
Presentation Secondary school	Clonmel, Co. Tipperary
Rice College	Castlebar Road, Westport, Co. Mayo
Sacred Heart Secondary School	Convent of Mercy, Clonakilty, Co. Cork
Saint Eunan's College	Letterkenny, Co. Donegal
St Aidan's Comprehensive School	Cootehill, Co. Cavan
St Brigids Mercy Secondary School	Convent Of Mercy, Tuam, Co. Galway
St Joseph's Secondary School	Convent Lane, Rush, Co. Dublin
St Mary's CBS	Millpark Road, Enniscorthy, Co. Wexford
St Vincent's Secondary School	Seatown Place, Dundalk, Co. Louth
St. Finian's Community College	Swords, Co. Dublin
Stratford College	1 Zion Road, Rathgar, Dublin 6
Synge St CBS	Synge St., Dublin 8
Terenure College	Templeogue Road, Terenure, Dublin 6W

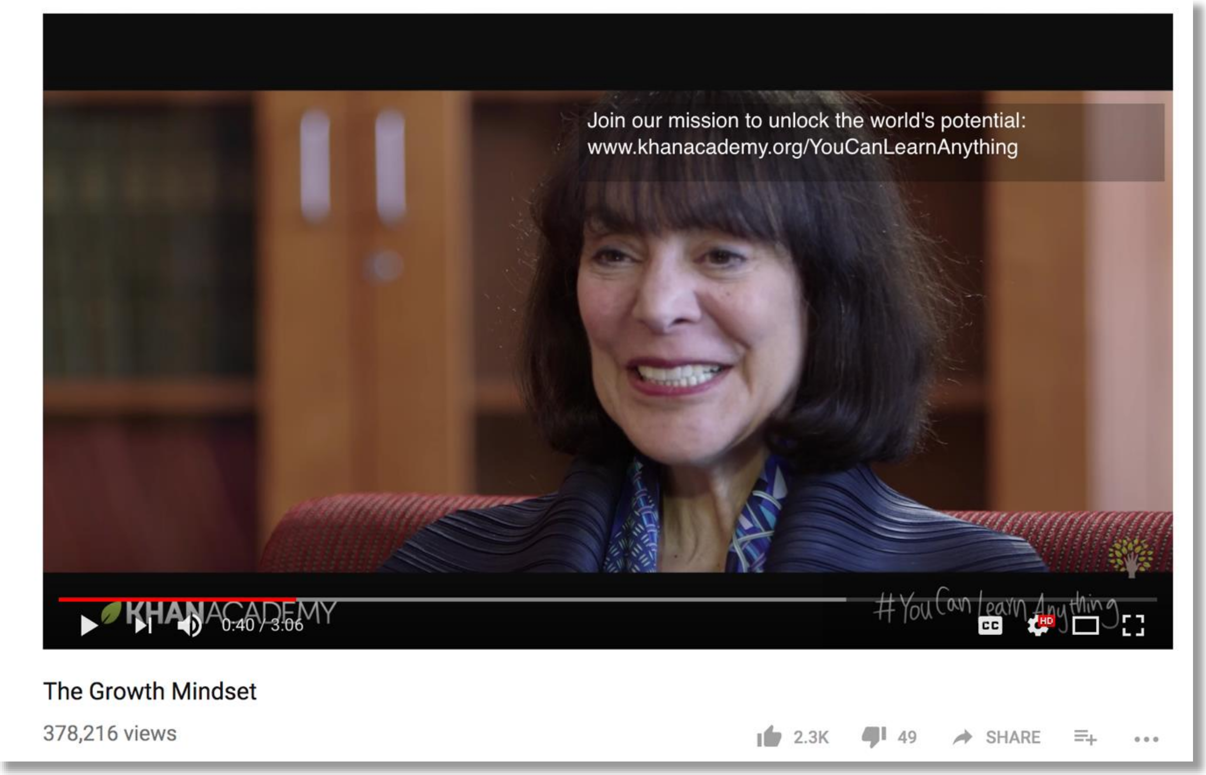
Google Map of Phase 1 Schools

Growth Mindset: An Introduction

Should you tell your kids they are smart or talented? Professor Carol Dweck answers this question and more, as she talks about her ground-breaking work on developing mindsets. She emphasises the power of "yet" in helping students succeed in and out of the classroom.

Watch the video presentation at - **https://youtu.be/hiiEeMN7vbQ**


Fixed Mind-set
Intelligence is static
Growth Mind-set
Intelligence can be developed
Leads to a desire to look smart and therefore a tendency to...
Leads to a desire to learn and therefore a tendency to...
CHALLENGES
...avoid challenges
...embrace challenges
OBSTACLES
...give up easily
...persist in the face of setbacks
EFFORT
...see effort as fruitless or worse
...see effort as the path to mastery
CRITICISM
...ignore useful negative feedback
...learn from criticism
SUCCESS OF OTHERS
...feel threatened by the success of others
...find lessons and inspiration in the success of others
As a result, they may plateau early and achieve less than their full potential.
All this confirms a deterministic view of the world.
As a result, they reach ever-higher levels of achievement.
All this gives them a greater sense of free will.
GRAPHIC BY NIGEL HOLMES



Sal Khan from the Khan Academy talks with Stanford Professor Carol Dweck about her research on Growth Mind-set.

Watch the video interview at - **https://youtu.be/wh0OS4MrN3E**

CS For All

Despite having made significant inroads into many traditionally male-dominated fields (e.g., biology, chemistry), women continue to be underrepresented in computer science. students' stereotypes about the culture of these fields - including the kind of people, the work involved, and the values of the field - steer girls away from choosing to enter them.

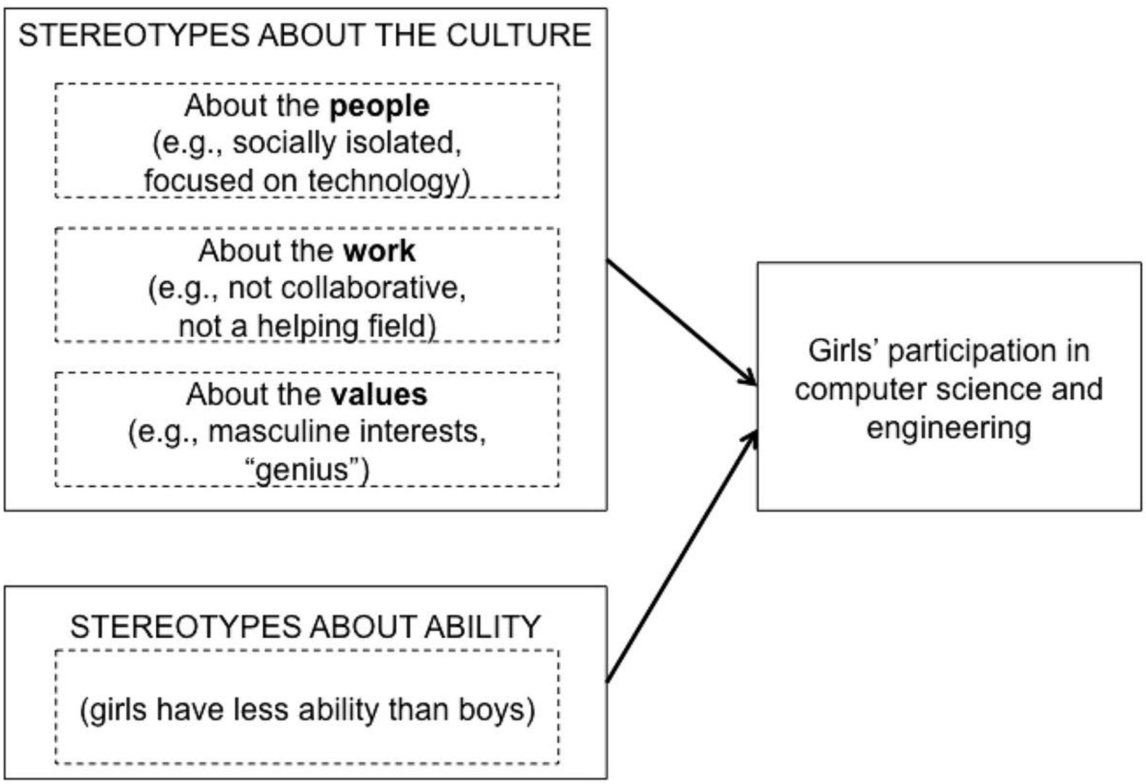


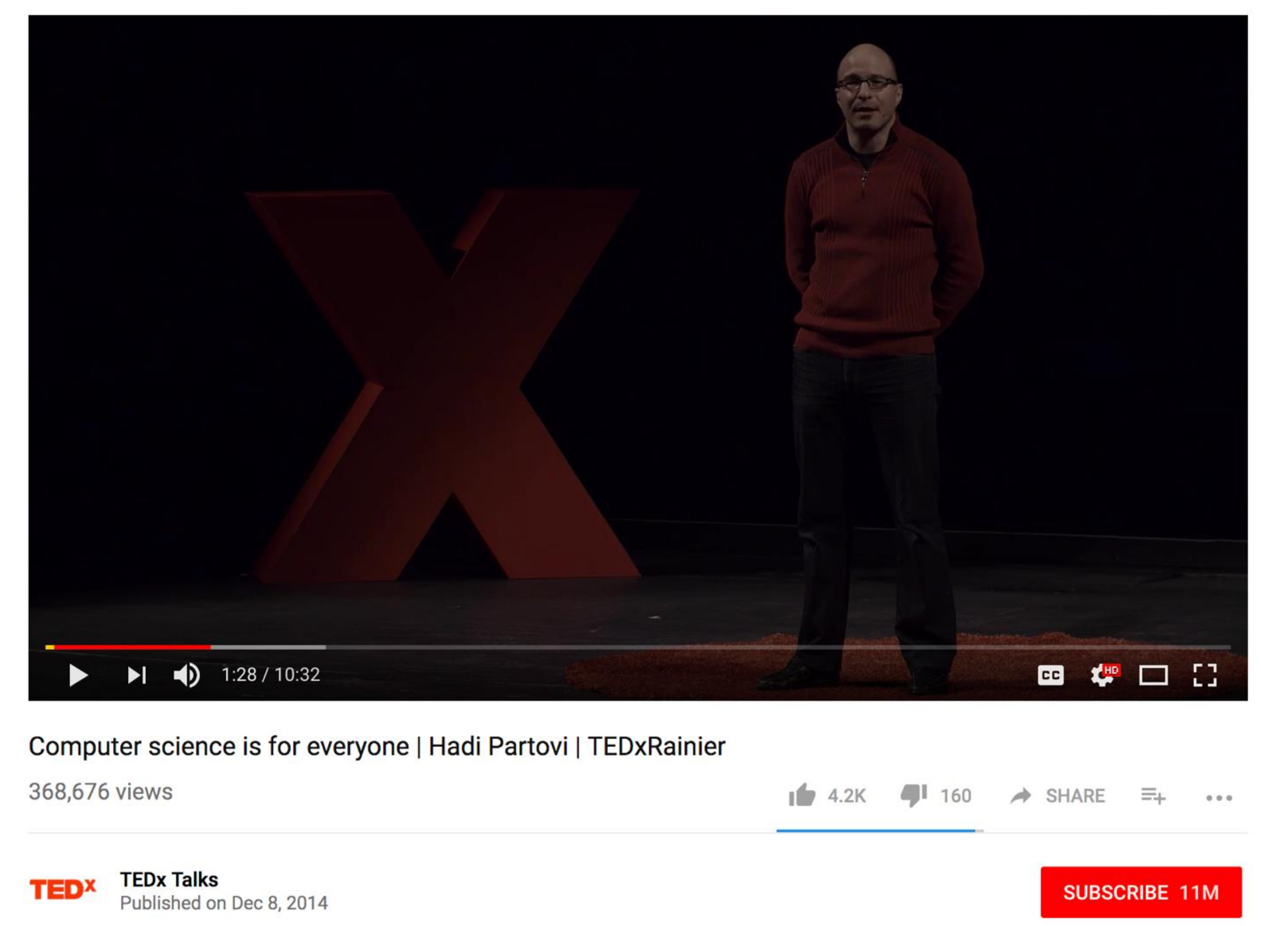
FIGURE 1. Students have stereotypes about the culture of computer science and engineering and girls face negative stereotypes about their abilities. Both types of stereotypes signal to girls that computer science and engineering are not appropriate fields for them.

Reference:

Cheryan S, Master A, Meltzoff A. Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes. Frontiers in Psychology. 2015;6(49):1–8.

Our world increasingly driven by technology and software, so we all need to know the creative, problem-solving power of computer science. This is especially important to students who will lead the way in our shared future.

Hadi Partovi learned computer science so he could have games to play on the computer his father gave him (a Commodore 64) when he was 10 years old in Iran. Since then he has worked as computer programmer and also as an entrepreneur, investor, and as co-founder of Code.org, a nonprofit dedicated to growing computer science education in the US and worldwide. Hadi has been Microsoft's Group Program Manager for Internet Explorer, was General Manager of MSN.com.



Watch the video presentation at - **https://youtu.be/FpMNs7H24X0**

Community of Practice

Smith, M. K. (2003, 2009) 'Jean Lave, Etienne Wenger and communities of practice', *the encyclopedia of informal education*, www.infed.org/biblio/communities_of_practice.htm.

Many of the ways we have of talking about learning and education are based on the assumption that learning is something that individuals do. Furthermore, we often assume that learning '*has a beginning and an end; that it is best separated from the rest of our activities; and that it is the result of teaching' (Wenger 1998: 3*). But how would things look if we took a different track? Supposing learning is social and comes largely from of our experience of participating in daily life? It was this thought that formed the basis of a significant rethinking of learning theory in the late 1980s and early 1990s by two researchers from very different disciplines – Jean Lave and Etienne Wenger. Their model of situated learning proposed that learning involved a process of engagement in a 'community of practice'.

Jean Lave was (and is) a social anthropologist with a strong interest in social theory, based at the University of California, Berkeley. Much of her work has focused on the 're-conceiving' of learning, learners, and educational institutions in terms of social practice. When looking closely at everyday activity, she has argued, it is clear that '*learning is ubiquitous in ongoing activity, though often unrecognized as such*' (Lave 1993: 5).

Etienne Wenger was a teacher who joined the Institute for Research on Learning, Palo Alto having gained a Ph.D. in artificial intelligence from the University of California at Irvine. (He is now an independent consultant specializing in developing communities of practice within organizations). Their path-breaking analysis, first published in *Situated Learning: Legitimate peripheral participation* (1991) and later augmented in works by Jean Lave (1993) and Etienne Wenger (1999; 2002) set the scene for some significant innovations in practice within organizations and more recently within some schools (see Rogoff *et al*2001).

Communities of practice

The basic argument made by Jean Lave and Etienne Wenger is that communities of practice are everywhere and that we are generally involved in a number of them – whether that is at work, school, home, or in our civic and leisure interests. Etienne Wenger was later to write:

> *Communities of practice are formed by people who engage in a process of collective learning in a shared domain of human endeavour: a tribe learning to survive, a band of artists seeking new forms of expression, a group of engineers working on similar problems, a clique of pupils defining their identity in the school, a network of surgeons exploring novel techniques, a gathering of first-time managers helping each other cope. In a nutshell: Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. (Wenger circa 2007)*

In some groups we are core members, in others we are more at the margins.

> *Being alive as human beings means that we are constantly engaged in the pursuit of enterprises of all kinds, from ensuring our physical survival to seeking the most lofty pleasures. As we define these enterprises and engage in their pursuit together, we interact with each other and with the world and we tune our relations with each other and with the world accordingly. In other words we learn.*
>
> *Over time, this collective learning results in practices that reflect both the pursuit of our enterprises and the attendant social relations. These practices are thus the property of a kind of community created over time by the sustained pursuit of a shared enterprise. It makes sense, therefore to call these kinds of communities of practice. (Wenger 1998: 45)*

The characteristics of such communities of practice vary. Some have names, many do not. Some communities of practice are quite formal in organization, others are very fluid and informal. However, members are brought together by joining in common activities and by 'what they have learned through their mutual engagement in these activities' (Wenger 1998). In this respect, a community of practice is different from a community of interest or a geographical community in that it involves a shared practice.

The characteristics of communities of practice

According to Etienne Wenger (c 2007), three elements are crucial in distinguishing a community of practice from other groups and communities:

The domain. A community of practice is is something more than a club of friends or a network of connections between people. 'It has an identity defined by a shared domain of interest. Membership therefore implies a commitment to the domain, and therefore a shared competence that distinguishes members from other people' (*op. cit.*).

The community. 'In pursuing their interest in their domain, members engage in joint activities and discussions, help each other, and share information. They build relationships that enable them to learn from each other' (*op. cit.*).

The practice. ‘Members of a community of practice are practitioners. They develop a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems- in short, a shared practice. This takes time and sustained interaction’ (*op. cit.*).

Relationships, identity and shared interests and repertoire

A community of practice involves, thus, much more than the technical knowledge or skill associated with undertaking some task. Members are involved in a set of relationships over time (Lave and Wenger 1991: 98) and communities develop around things that matter to people (Wenger 1998). The fact that they are organizing around some particular area of knowledge and activity gives members a sense of joint enterprise and identity. For a community of practice to function it needs to generate and appropriate a shared repertoire of ideas, commitments and memories. It also needs to develop various resources such as tools, documents, routines, vocabulary and symbols that in some way carry the accumulated knowledge of the community. In other words, it involves practice: ways of doing and approaching things that are shared to some significant extent among members.
The interactions involved, and the ability to undertake larger or more complex activities and projects though cooperation, bind people together and help to facilitate relationship and trust (see the discussion of community elsewhere on these pages). Communities of practice can be seen as self-organizing systems and have many of the benefits and characteristics of associational life such as the generation of what Robert Putnam and others have discussed as social capital.

Legitimate peripheral participation and situated learning

Rather than looking to learning as the acquisition of certain forms of knowledge, Jean Lave and Etienne Wenger have tried to place it in social relationships – situations of co-participation. As William F. Hanks puts it in his introduction to their book: ‘Rather than asking what kind of cognitive processes and conceptual structures are involved, they ask what kinds of social engagements provide the proper context for learning to take place’ (1991: 14). It not so much that learners acquire structures or models to understand the world, but they participate in frameworks that that have structure. Learning involves participation in a community of practice. And that participation ‘refers not just to local events of engagement in certain activities with certain people, but to a more encompassing process of being active participants in the *practices* of social communities and constructing *identities* in relation to these communities' (Wenger 1999: 4).

Lave and Wenger illustrate their theory by observations of different apprenticeships (Yucatec midwives, Vai and Gola tailors, US Navy quartermasters, meat-cutters, and non-drinking alcoholics in Alcoholics Anonymous). Initially people have to join communities and learn at the periphery. The things they are involved in, the tasks they do may be less key to the community than others.

As they become more competent they become more involved in the main processes of the particular community. They move from legitimate peripheral participation to into 'full participation (Lave and Wenger 1991: 37). Learning is, thus, not seen as the acquisition of knowledge by individuals so much as a process of *social* participation. The nature of the *situation* impacts significantly on the process.

> Learners inevitably participate in communities of practitioners and… the mastery of knowledge and skill requires newcomers to move toward full participation in the socio-cultural practices of a community. "Legitimate peripheral participation" provides a way to speak about the relations between newcomers and old-timers, and about activities, identities, artefacts, and communities of knowledge and practice. A person's intentions to learn are engaged and the meaning of learning is configured through the process of becoming a full participant in a socio-cultural practice. This social process, includes, indeed it subsumes, the learning of knowledgeable skills. (Lave and Wenger 1991: 29)

In this there is a concern with identity, with learning to speak, act and improvise in ways that make sense in the community. What is more, and in contrast with learning as internalization, 'learning as increasing participation in communities of practice concerns the whole person acting in the world' (Lave and Wenger 1991: 49). The focus is on the ways in which learning is 'an evolving, continuously renewed set of relations' (ibid.: 50). In other words, this is a relational view of the person and learning.

Situated learning

This way of approaching learning is something more than simply 'learning by doing' or experiential learning. As Mark Tennant (1997: 73) has pointed out, Jean Lave's and Etienne Wenger's concept of situatedness involves people being full participants in the world and in generating meaning. 'For newcomers', Jean Lave and Etienne Wenger (1991: 108-9) comment, 'the purpose is not to learn *from* talk as a substitute for legitimate peripheral participation; it is to learn *to* talk as a key to legitimate peripheral participation'. This orientation has the definite advantage of drawing attention to the need to understand knowledge and learning in context. However, situated learning depends on two claims:

- It makes no sense to talk of knowledge that is decontextualized, abstract or general.
- New knowledge and learning are properly conceived as being located in communities of practice (Tennant 1997: 77).

Questions can be raised about both of these claims. It may be, with regard to the first claim, for example, that learning can occur that is seemingly unrelated to a particular context or life situation.

Second, there may situations where the community of practice is weak or exhibits power relationships that seriously inhibit entry and participation. There is a risk, as Jean Lave and Etienne Wenger acknowledge, of romanticizing communities of practice. However, there has been a tendency in their earlier work of falling into this trap. 'In their eagerness to debunk testing, formal education and formal accreditation, they do not analyse how their omission [of a range of questions and issues] affects power relations, access, public knowledge and public accountability' (Tennant 1997: 79). Their interest in the forms of learning involved communities of practice shares some common element with Ivan Illich's advocacy of learning webs and informal education. However, where Jean Lave and Etienne Wenger approached the area through an exploration of local encounters and examples, Ivan Illich started with a macro-analysis of the debilitating effects of institutions such as schooling. In both cases the sweep of their arguments led to an under-appreciation of the uses of more formal structures and institutions for learning. However, this was understandable given the scale of the issues and problems around learning within professionalized and bureaucratic institutions such as schools their respective analyses revealed.

Learning organisations and learning communities

These ideas have been picked-up most strongly within organizational development circles. The use of the apprenticeship model made for a strong set of connections with important traditions of thinking about training and development within organizations. Perhaps more significantly, the growing interest in 'the learning organization' in the 1990s alerted many of those concerned with organizational development to the significance of informal networks and groupings. Jean Lave's and Etienne Wenger's work around communities of practice offered a useful addition. It allowed proponents to argue that communities of practice needed to be recognized as valuable assets. The model gave those concerned with organizational development a way of thinking about how benefits could accrue to the organization itself, and how value did not necessarily lie primarily with the individual members of a community of practice.

> *Acknowledging that communities of practice affect performance is important in part because of their potential to overcome the inherent problems of a slow-moving traditional hierarchy in a fast-moving virtual economy. Communities also appear to be an effective way for organizations to handle unstructured problems and to share knowledge outside of the traditional structural boundaries. In addition, the community concept is acknowledged to be a means of developing and maintaining long-term organizational memory. These outcomes are an important, yet often unrecognized, supplement to the value that individual members of a community obtain in the form of enriched learning and higher motivation to apply what they learn. (Lesser and Storck 2001.*

Lesser and Storck go on to argue that the social capital resident in communities of practice leads to behavioural change—'change that results in greater knowledge sharing, which in turn positively influences business performance'. Attention to communities of practice could, thus enhance organizational effectiveness and profitability.

For obvious reasons, formal education institutions have been less ready to embrace these ideas. There was a very real sense in which the direction of the analysis undermined their reason for being and many of their practices. However, there have been some significant explorations of how schooling, for example, might accommodate some of the key themes and ideas in Jean Lave's and Etienne Wenger's analysis. In particular, there was significant mileage in exploring how communities of practice emerge within schooling, the process involved and how they might be enhanced. Furthermore, there was also significant possibility in a fuller appreciation of what constitutes practice (as earlier writers such Carr and Kemmis 1986, and Grundy 1987 had already highlighted). Perhaps the most helpful of these explorations is that of Barbara Rogoff and her colleagues (2001). They examine the work of an innovative school in Salt Lake City and how teachers, students and parents were able to work together to develop an approach to schooling based around the principle that learning 'occurs through interested participation with other learners'.

Conclusion – issues and implications for educators

Jean Lave's and Etienne Wenger's concern here with learning through participation in group/collective life and engagement with the 'daily round' makes their work of particular interest to informal educators and those concerned with working with groups. These are themes that have part of the informal education tradition for many years – but the way in which Jean Lave and Etienne Wenger have developed an understanding of the nature of learning within communities of practice, and how knowledge is generated allows educators to think a little differently about the groups, networks and associations with which they are involved. It is worth looking more closely at the processes they have highlighted.

The notion of community of practice and the broader conceptualization of situated learning provides significant pointers for practice. Here I want to highlight three:

Learning is in the relationships between people. As McDermott (in Murphy 1999:17) puts it:

> *Learning traditionally gets measured as on the assumption that it is a possession of individuals that can be found inside their heads… [Here] learning is in the relationships between people. Learning is in the conditions that bring people together and organize a*

point of contact that allows for particular pieces of information to take on a relevance; without the points of contact, without the system of relevancies, there is not learning, and there is little memory. Learning does not belong to individual persons, but to the various conversations of which they are a part.

Within systems oriented to individual accreditation, and that have lost any significant focus on relationship through pressures on them to meet centrally-determined targets, this approach to learning is challenging and profoundly problematic. It highlights just how far the frameworks for schooling, lifelong learning and youth work in states like Britain and Northern Ireland have drifted away from a proper appreciation of what constitutes learning (or indeed society). Educators have a major educational task with policymakers as well as participants in their programmes and activities.

Educators work so that people can become participants in communities of practice*.* Educators need to explore with people in communities how all may participate to the full. One of the implications for schools, as Barbara Rogoff and her colleagues suggest is that they must prioritize 'instruction that builds on children's interests in a collaborative way'. Such schools need also to be places where 'learning activities are planned by children as well as adults, and where parents and teachers not only foster children's learning but also learn from their own involvement with children' (2001: 3). Their example in this area have particular force as they are derived from actual school practice.

A further, key, element is the need to extend associational life within schools and other institutions. Here there is a strong link here with long-standing concerns among informal educators around community and participation and for the significance of the group (for schooling see the discussion of informal education and schooling; for youth work see young people and association; and for communities see community participation).

There is an intimate connection between knowledge and activity*.* Learning is part of daily living as Eduard Lindeman argued many years ago. Problem solving and learning from experience are central processes (although, as we have seen, situated learning is not the same as ‘learning by doing’ – see Tennant 1997: 73). Educators need to reflect on their understanding of what constitutes knowledge and practice. Perhaps one of the most important things to grasp here is the extent to which education involves informed and committed action.

These are fascinating areas for exploration and, to some significant extent, take informal educators in a completely different direction to the dominant pressure towards accreditation and formalization.

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Acknowledgements:

The picture 'Community of practice' is taken from sonson's photosream at Flickr [http://www.flickr.com/photos/sonson/422595428/] and reproduced under a Creative Commons Attribution-Non-Commercial-No Derivative Works 2.0 Generic Licence.

Smith, M. K. (2003, 2009) 'Jean Lave, Etienne Wenger and communities of practice', *the encyclopedia of informal education*, www.infed.org/biblio/communities_of_practice.htm.

Wenger-Trayner

What are communities of practice?

Communities of practice are formed by people who engage in a process of collective learning in a shared domain of human endeavor: a tribe learning to survive, a band of artists seeking new forms of expression, a group of engineers working on similar problems, a clique of pupils defining their identity in the school, a network of surgeons exploring novel techniques, a gathering of first---time managers helping each other cope. In a nutshell:

> *Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly.*
> *Note that this definition allows for, but does not assume, intentionality: learning can be the reason the community comes together or an incidental outcome of member's interactions. Not everything called a community is a community of practice. A neighborhood for instance, is often called a community, but is usually not a community of practice. Three characteristics* are crucial:

The domain: A community of practice is not merely a club of friends or a network of connections between people. It has an identity defined by a shared domain of interest. Membership therefore implies a commitment to the domain, and therefore a shared competence that distinguishes members from other people. (You could belong to the same network as someone and never know it.) The domain is not necessarily something recognized as “expertise” outside the community. A youth gang may have developed all sorts of ways of dealing with their domain: surviving on the street and maintaining some kind of identity they can live with. They value their collective competence and learn from each other, even though few people outside the group may value or even recognize their expertise.

The community: In pursuing their interest in their domain, members engage in joint activities and discussions, help each other, and share information. They build relationships that enable them to learn from each other; they care about their standing with each other. A website in itself is not a community of practice. Having the same job or the same title does not make for a community of practice unless members interact and learn together. The claims processors in a large insurance company or students in American high schools may have much in common, yet unless they interact and learn together, they do not form a community of practice. But members of a community of practice do not necessarily work together on a daily basis. The Impressionists, for instance, used to meet in cafes and studios to discuss the style of painting they were inventing together. These interactions were essential to making them a community of practice even though they often painted alone.

The practice: A community of practice is not merely a community of interest-people who like certain kinds of movies, for instance. Members of a community of practice are practitioners. They develop a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems—in short, a shared practice. This takes time and sustained interaction. A good conversation with a stranger on an airplane may give you all sorts of interesting insights, but it does not in itself make for a community of practice. The development of a shared practice may be more or less self---conscious. The “windshield wipers” engineers at an auto manufacturer make a concerted effort to collect and document the tricks and lessons they have learned into a knowledge base. By contrast, nurses who meet regularly for lunch in a hospital cafeteria may not realize that their lunch discussions are one of their main sources of knowledge about how to care for patients. Still, in the course of all these conversations, they have developed a set of stories and cases that have become a shared repertoire for their practice.

It is the combination of these three elements that constitutes a community of practice. And it is by developing these three elements in parallel that one cultivates such a community.

Acknowledgements:
Communities of Practice: a brief introduction - Etienne and Beverly Wenger-Trayner
http://wenger-trayner.com/wp-content/uploads/2015/04/07-Brief-introduction-to-communities-of-practice.pdf

Session 2

Today's Schedule

09.00am - 11.00am	Session 2 - Subject Specification
11.00am - 11.30am	Coffee & Stretch Break
11.30am - 1.00pm	Session 3 - Experiencing Problem Solving (Thru the lens of a learner)
1.00pm - 1.45pm	Lunch
1.45pm - 3.45pm	Session 4 - Pedagogy, Reflection and Resource Development
3.45pm - 4.00pm	Wrap up

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Question Board

slack

Workspace = pdstcs

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Recap on Key Messages

- Computer Science is a subject for everybody.
- There are many ways to use the specification.
- All learning outcomes are interwoven and can be studied in any order.
- LCCS can be effectively mediated through the use of a constructivist pedagogical orientation.
- Digital technologies have the potential to enhance collaboration, learning and reflection.

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Session 2 – Specification

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Leaving Certificate Computer Science Curriculum Specification

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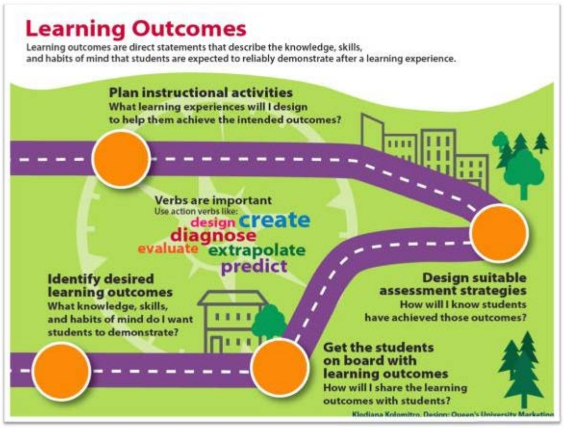
‘Learning outcomes can best be defined as statements of what a learner knows, understands and is able to do after completion of learning.’

CEDEFOP (2009)

Notes



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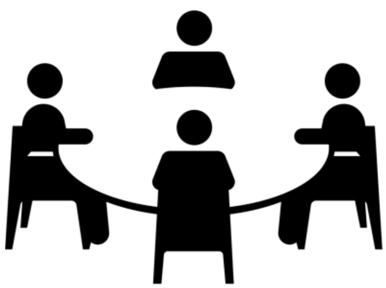
Group Activity



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Group Warmup Activity - Instructions

Log onto the shared document and examine the learning outcomes and how they are grouped by strands of the course and by lower and higher order thinking.

https://tinyurl.com/ybx9cjgw

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https://tinyurl.com/ybx9cjgw

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Group Activity A - Instructions

Each group should pick 2 different learning outcomes.

Discuss and write down:

- *What would you teach to your class for this LO?*
- *What teaching & learning strategies could you use?*
- *How would you know this learning outcome has been achieved?*
- *Can it be linked to other parts of the course?*

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padlet

Notes

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https:// pdstlccs.padlet.org/cpd/

Group 1 : 7710g7172nuy

Group 2 : qklzwqf6h9hx

Group 3 : bv1ntbl6arh9

Group 4 : ir6njapfd7k3

Group 5 : o4r1npyac4c6

Group 6 : 7i4lyjo08fee

Group 7 : 4pfmcsiwddd5

Group 8 : eu976w6thph2

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Benefits of Learning Outcomes for Teachers

Effective course design	• By keeping learning outcomes front and center, teachers can develop courses in which all aspects of the course, including learning activities and assessments, support what they want students to learn *[a]*
Effective assessment of learning	• Clear expectations make it easier to evaluate students' progress and ensure that assessments are targeting the appropriate level of knowledge or skill *[a, b]*
Better time management	• Well-defined learning outcomes simplify difficult decisions about what content to include and what to omit when preparing lessons and assessments *[b, c]*
Improved communication	• Teachers can use learning outcomes to have explicit and constructive dialogues with students about the course and their learning, and with colleagues about the expectations of courses *[b]*
Improved teaching experience	• Teachers who use learning objectives report less anxiety, more confidence interacting with students, and use more diverse teaching and assessment approaches *[b, c]*

[a] Wang, X., Su, Y., Cheung, S., Wong, E., & Kwong, T. (2013). An exploration of Biggs' constructive alignment in course design and its impact on students' learning approaches. *Assessment and Evaluation in Higher Education, 38*, 477-491.
[b] Simon, B., & Taylor, J. (2009). What is the value of course-specific learning goals? *Journal of College Science Teaching, 39*, 52-57.
[c] Reynolds, H. L., & Kearns, K. D. (2017). A planning tool for incorporating backward design, active learning, and authentic assessment in the college classroom. *College Teaching, 65*, 17-27.

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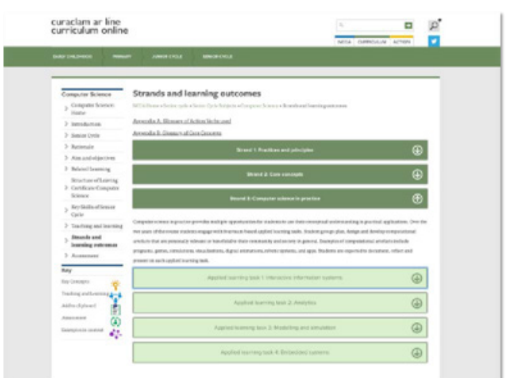

https://www.curriculumonline.ie

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Constructivist Pedagogical Orientation

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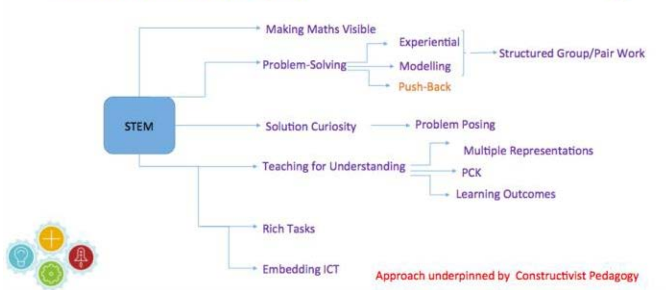
STEM CPD

STEM as a Connected Discipline



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Applied Learning Tasks

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Students work in teams to carry out four applied learning tasks over the duration of the course.

Each of which results in the creation of a real or virtual computational artefact.

These artefacts should relate to the students' lives and interests.

Where possible, the artefacts should be beneficial to the community and society in general.

Examples of computational artefacts include programs, games, web pages, simulations, visualisations, digital animations, robotic systems, and apps.

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The four applied learning tasks explore the four following contexts:

- Interactive information systems
- Analytics
- Modelling and simulation
- Embedded systems.

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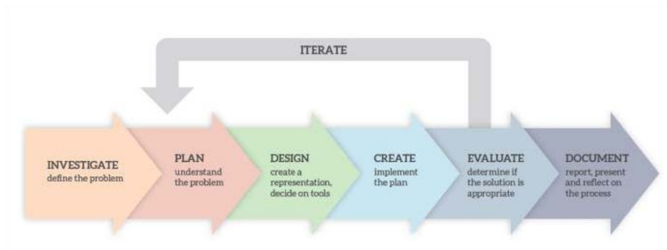

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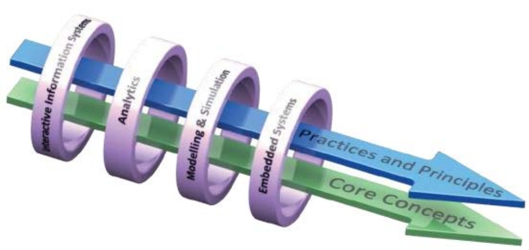
LCCS Interwoven



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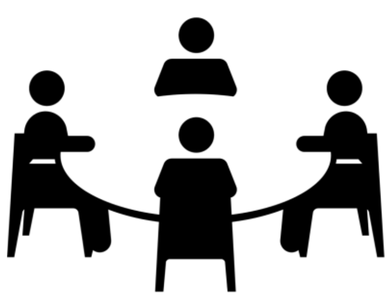
Group Activity



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Professional Development Service for Teachers | An tSeirbhís um Fhorbairt Ghairmiúil do Mhúinteoirí

padlet

Activity B

1. Each group will be given an online Padlet board and a particular ALT – eg Embedded System.
2. In groups start brainstorming as to possible project ideas for students. Aim for as many ideas as you can.
3. Fill in your ideas on your board – can be text / images etc.
4. Present ideas to the wider group.

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https:// pdstlccs.padlet.org/cpd/

Group 1 :	**j937s0io4cn5**
Group 2 :	**53arxaktbfx5**
Group 3 :	**gjqw6kujq34m**
Group 4 :	**7ib54uihkgxq**
Group 5 :	**gfgybasv53z6**
Group 6 :	**4qgxb1unzx18**
Group 7 :	**rhqme64boani**
Group 8 :	**zb19lfnqsua5**

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padlet

Activity C

1. Each group will be given an additional Padlet board online.
2. Pick 1 - 2 different ideas from the previous brainstorm.
3. Look again at your idea - this time you will be given some prompt question to consider.
4. Present ideas to the wider group.

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https:// pdstlccs.padlet.org/cpd/

Group 1 :	**qk3h9ye4jie5**
Group 2 :	**n9i73sqvq5nb**
Group 3 :	**cklkkwexg3gt**
Group 4 :	**mrir62jqkd14**
Group 5 :	**mqlshc7tsmpm**
Group 6 :	**58ef9fdyhy8g**
Group 7 :	**w8zc0q5hwb2x**
Group 8 :	**cfqgt3kwbyyr**

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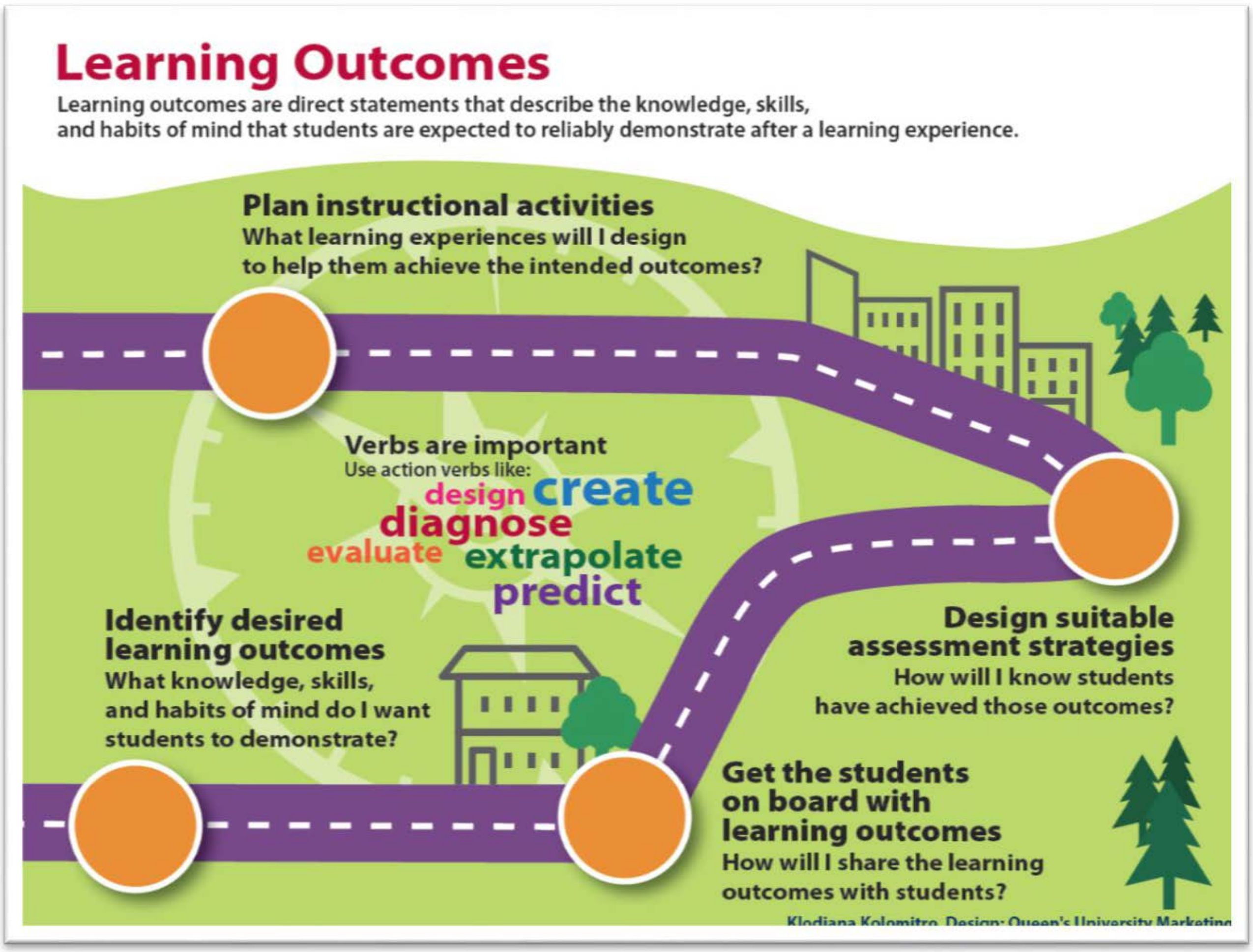
- *What teaching & learning strategies could you use?*
- *How would you assess?*
- *Can it be linked to other parts of the course?*
- *In terms of planning where in the course do you see this ALT fitting in?*

Notes

Learning Outcomes



Benefits of Learning Outcomes for Teachers

Effective course design	• By keeping learning outcomes front and center, teachers can develop courses in which all aspects of the course, including learning activities and assessments, support what they want students to learn *(a)*.
Effective assessment of learning	• Clear expectations make it easier to evaluate students' progress and ensure that assessments are targeting the appropriate level of knowledge or skill *(a, b)*.
Better time management	• Well-defined learning outcomes simplify difficult decisions about what content to include and what to omit when preparing lessons and assessments *(b, c)*.
Improved communication	• Teachers can use learning outcomes to have explicit and constructive dialogues with students about the course and their learning, and with colleagues about the expectations of courses *(b)*.
Improved teaching experience	• Teachers who use learning objectives report less anxiety, more confidence interacting with students, and use more diverse teaching and assessment approaches *(b, c)*.

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[b] Simon, B., & Taylor, J. (2009). What is the value of course-specific learning goals? *Journal of College Science Teaching, 39*, 52-57.

[c] Reynolds, H. L., & Kearns, K. D. (2017). A planning tool for incorporating backward design, active learning, and authentic assessment in the college classroom. *College Teaching, 65*, 17-27.

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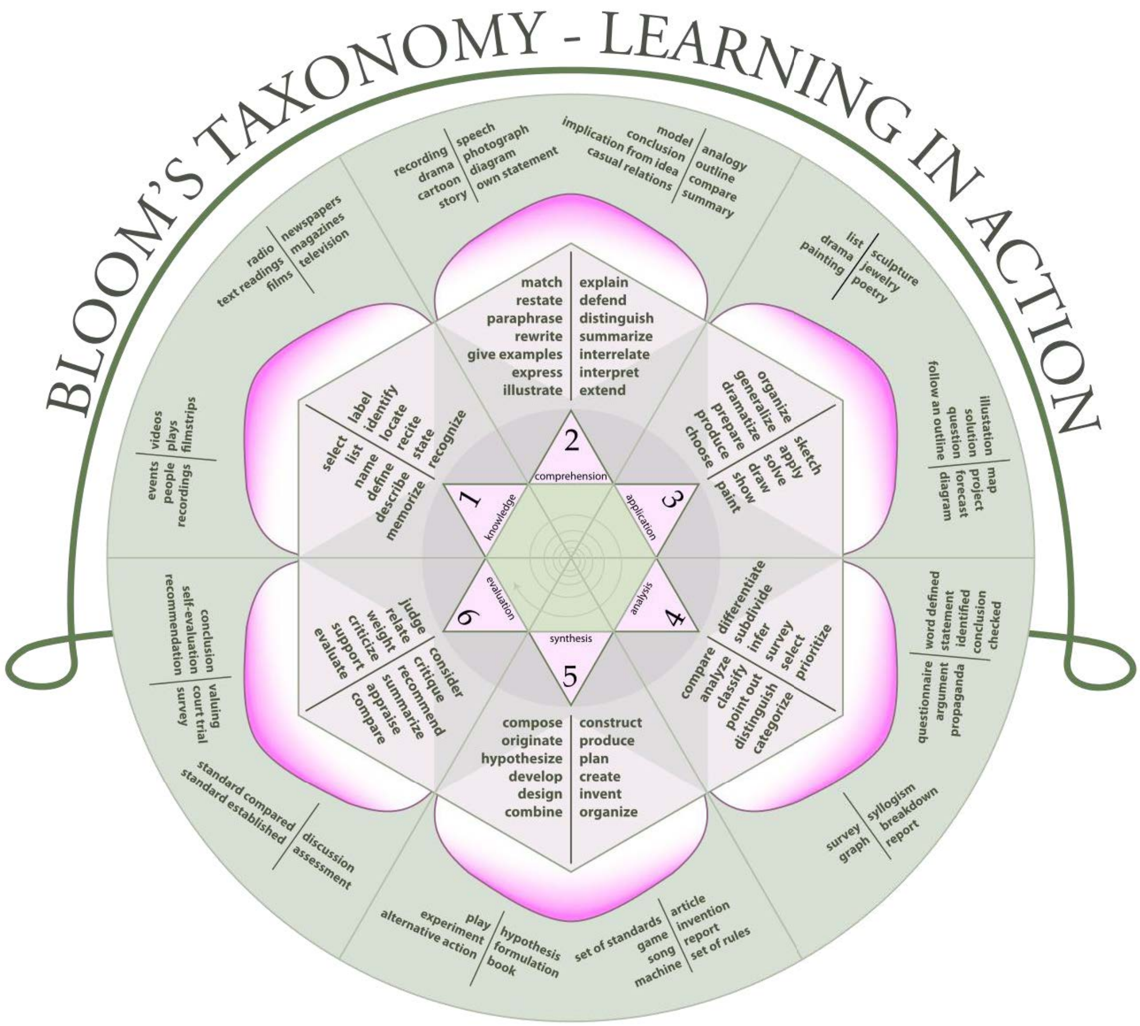


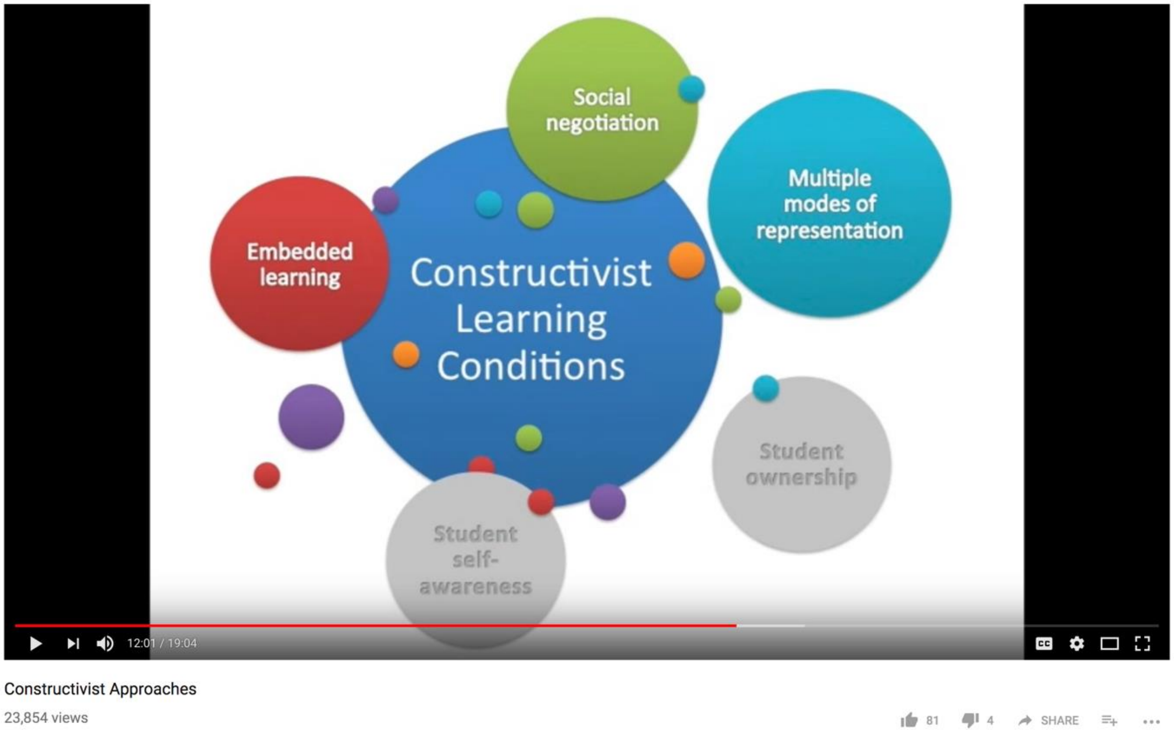
http://commons.wikimedia.org/wiki/Image:Bloom%27s_Rose.png by John M. Kennedy T.

Constructivist Pedagogical Orientation

Traditional Classroom	Constructivist Classroom
Curriculum begins with the parts of the whole. Emphasizes basic skills.	Curriculum emphasizes big concepts, beginning with the whole and expanding to include the parts.
Strict adherence to fixed curriculum is highly valued.	Pursuit of student questions and interests is valued.
Materials are primarily textbooks and workbooks.	Materials include primary sources of material and manipulative materials.
Learning is based on repetition.	Learning is interactive, building on what the student already knows.
Teachers disseminate information to students; students are recipients of knowledge.	Teachers have a dialogue with students, helping students construct their own knowledge.
Teacher's role is directive, rooted in authority.	Teacher's role is interactive, rooted in negotiation.
Assessment is through testing, correct answers.	Assessment includes student works, observations, and points of view, as well as tests. Process is as important as product.
Knowledge is seen as inert.	Knowledge is seen as dynamic, ever changing with our experiences.
Students work primarily alone.	Students work primarily in groups.

https://www.thirteen.org/edonline/concept2class/constructivism/index_sub1.html

Constructivist Approaches by Susie Gronseth - University of Houston.
This video presentation provides a brief overview of constructivism, discusses constructivist learning conditions in the classroom.



Watch the video presentation at - **https://youtu.be/krqjqGIuC-A**

Session 3: Problem solving through the lens of a learner

Background to Leaving Certificate Computer Science

In February 2018 Minister Richard Bruton, TD and Minister for Education and Skills officially launched Computer Science as a new standalone subject to the Irish Senior Cycle curriculum.

The subject specification itself was developed by the National Council for Curriculum and Assessment (NCCA) Computer Science Development Group (see Appendix A).

At a Symposium hosted by the Computers in Education Society of Ireland (CESI) in September 2017, Dr. Elizabeth Oldham of Trinity College Dublin presented a brief history of computer science education in Ireland. Her presentation included some key historical milestones which serve to provide a contextual background to the launch of the Computer Science specification.

The full presentation can be seen at https://www.youtube.com/watch?v=8r6fSW0d1W8&feature=youtu.be

Elizabeth Oldham at the 2017 CESI Computer Science Symposium

The table below outlines just a few of the more recent key documents which are relevant to the introduction of Leaving Certificate Computer Science.

<u>Digital Strategy for Schools 2015-2020</u>

"A programme of curriculum reforms will see ICT embedded in all emerging curricular specifications and intense preparation for the phased introduction of Computer Science as a Leaving Certificate subject option from 2018" (Digital Strategy Action Plan 2017)

<u>STEM Education in the Irish School System: </u>(Nov 2016)

Computer science (including coding) to be introduced as a Leaving Certificate curriculum subject. This is critical to address the ICT skills deficit in Ireland.

The use of digital technology can and should be used to further enhance engagements between schools, the local community, enterprise and parents. Examples might include …. new forms of CPD to educate teachers in computer science

<u>Feb 2017 Action Plan for Education:</u>

We will further accelerate the Digital and ICT agenda in schools by including a coding course for the Junior Cycle and introducing ICT/Computer Science as a Leaving Certificate subject.

Steering Group to develop and oversee implementation plan for the introduction of Leaving Certificate Computer Science in schools from September 2018.

<u>Computer Science in Upper Second Level Education Internationally</u>
A report which details the findings of research conducted into the international provision of Computer Science courses at upper second level across a number of selected jurisdictions. The research was commissioned by the National Council for Curriculum and Assessment (NCCA), and conducted by a consortium of researchers from Lero (The Irish Software Research Centre), the National Centre for STEM at the School of Education in the University of Limerick and the Third Level Computing Forum.

Key publications leading to the development of Leaving Certificate Computer Science

Historical Context

- **1980** — Computer Studies introduced as an interim option in LC Mathematics
- **1981** — *"It is my firm intention that Computer Studies will be formally introduced into second-level curriculum as a separate subject by the school-year … at the latest"*, Minister John Wilson
- **1985** — Computer Studies introduced as an Intermediate Certificate subject
- **1993** — *"Education and the New Technologies of ICT"*, NCCA discussion paper
- **2004** — *"Difficulties and Dichotomies"*, O' Doherty et. al. (NCCA)
- **2006+** — International Influence: *Computational Thinking* (Wing, 2006) and *Computer Science in New Zealand High Schools* (Bell, Andreae and Lambert, 2010

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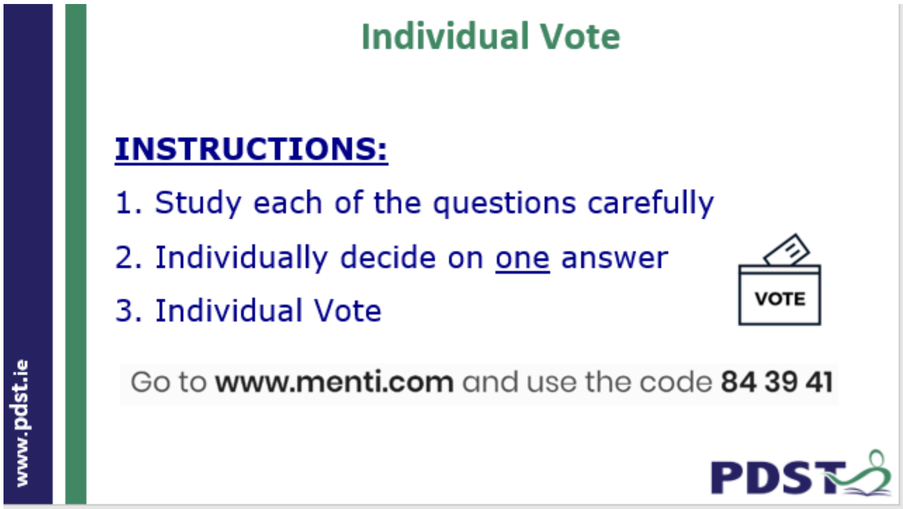
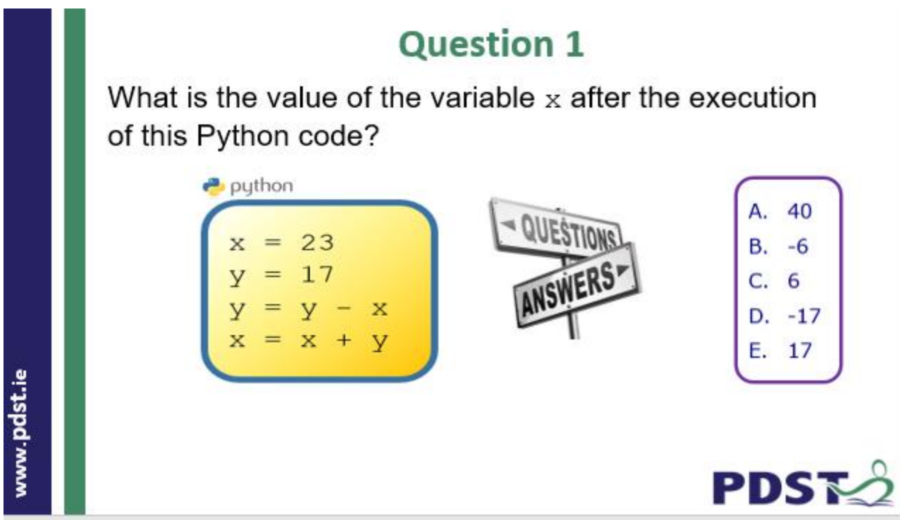
Warmup Activity

Throughout the entire session participants should bear in mind that *we are looking at problems through the lens of a learner*. In this section we will be using Mentimeter to answer four multiple choice questions (MCQs).



Mentimeter

- ✓ Student response system
- ✓ Device Neutral
- ✓ Anonymous
- ✓ Quick to Access



- ➢ This is question 1 of 4
- ➢ Possible answers to all questions are A, B, C, D or E
- ➢ No conferring please!

Notes

Question 2

What output does the Python code below display?

python

```
x = True
x = x+1
print(x)
```

A. 2
B. True
C. False
D. Syntax Error
E. 1

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- Keep going – this is question 2 of 4
- Don't worry about being incorrect.
- All results are anonymous!

Notes

Question 3

What output does the Python code below display?

python

```
x = 0
y = (x == 21%7)
Print(y)
```

A. 0
B. True
C. False
D. Syntax Error
E. 3

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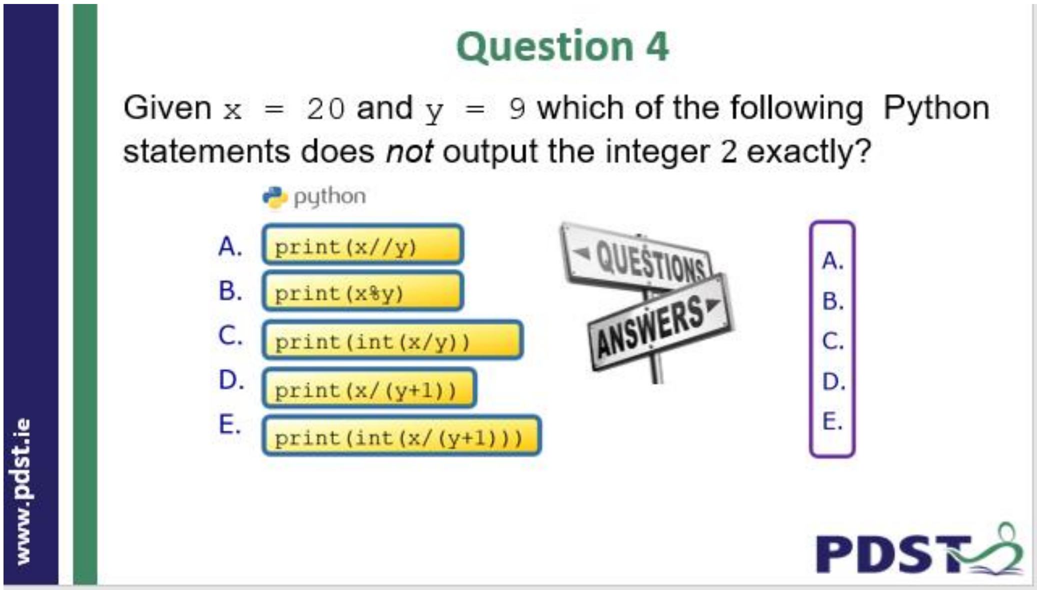
PDST

- Almost there – this is question 3 of 4
- You will have an opportunity to discuss with others later

Notes



- Well done – this is the final question!

Notes

Well done!

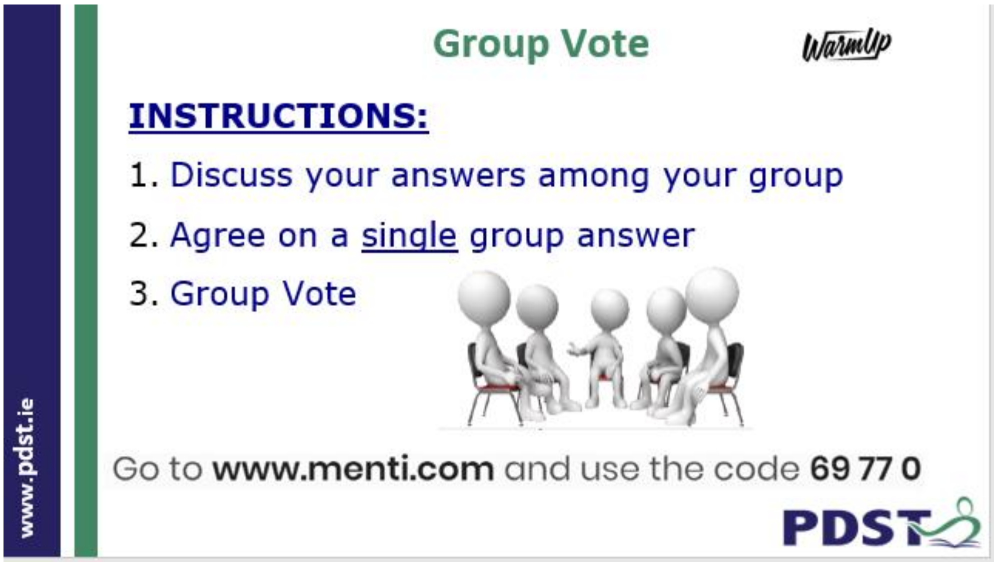
Before seeing the correct answers let's first discuss at our tables.

Following the table discussion, there will be an opportunity to vote again!

Guidelines for positive group discussion

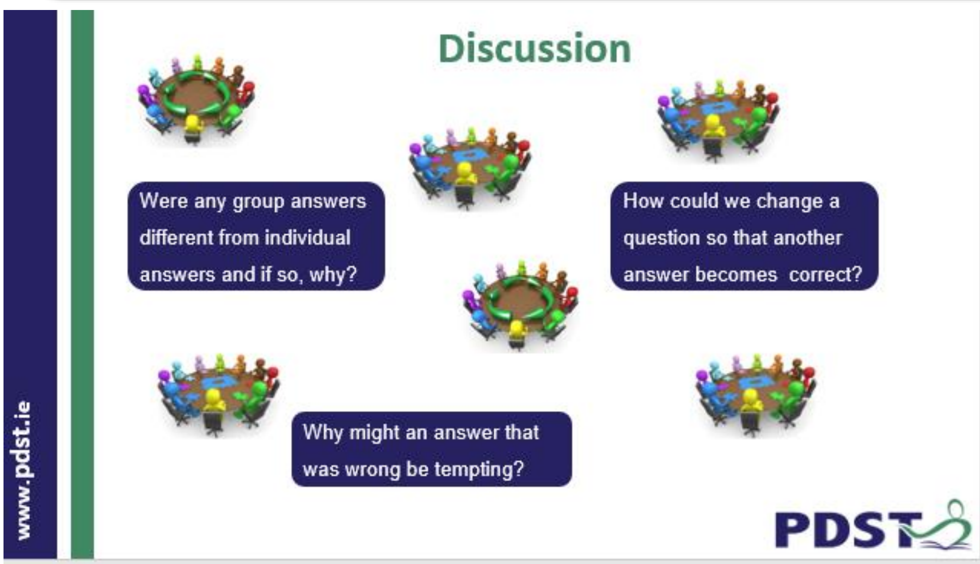
- Everyone participates
- Everyone shows respect
- Everyone is focused on the task
- One person speaks at a time
- Be nice – compliment one another

Feel free to use these guidelines in your own classroom.



- Appoint a 'chair'
- Compare answers
- Discuss differences
- Agree upon a single answer and vote!

Notes



Answers

1.
2.
3.
4.

Use the space provided on the next page to record your thoughts

Discussion

Were any group answers different from individual answers and if so, why?

Why might an answer that was wrong be tempting?

How could we change a question so that another answer becomes correct?

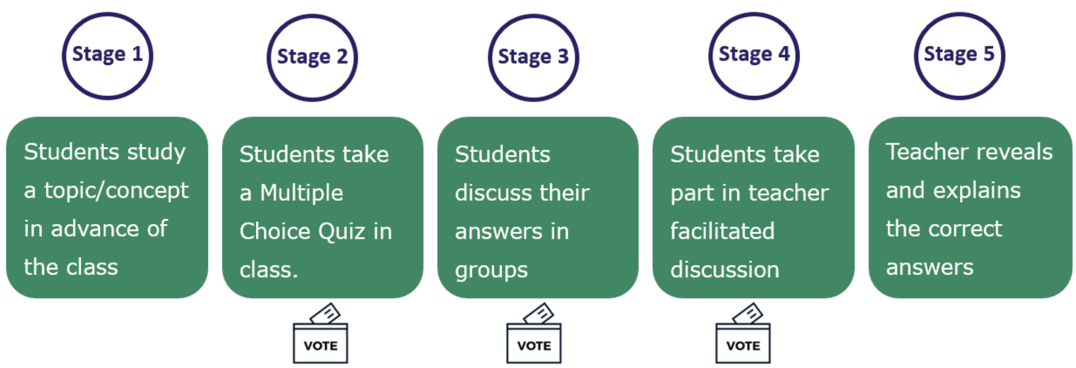
Peer Instruction

The warmup activity is an example of a slightly modified version of a programming pedagogy called *peer instruction*.

Peer instruction is a well-evidenced pedagogical strategy developed by Eric Mazur at Harvard University and has been used successfully in Physics, Mathematics and Computer Science. It involves a combination of flipped learning and collaborative working - based on carefully designed Multiple Choice Questions (MCQs) with structured discussion and voting.

Peer instruction offers a way of assessing whether novices really understand concepts that require a precise understanding. It is especially useful for testing *faulty mental models*.

The five key stages of peer instruction are illustrated in the diagram below



Research findings show that when used as an alternative to teacher explanation peer instruction[1]

- has a statistically significant effect on learning
- is twice as effective as a good teacher explanation
- develops a better sense of self efficacy *especially among girls*

For more information on peer instruction see http://peerinstruction4cs.org

[1] Source: Strategies for teaching programming (Sue Sentence, CAS South East Conference, July 2017)

Metacognition and Models of Learning

Although the interest in and study of how we learn have been around throughout history it was not until the early 20th century that the scientific study of learning began in earnest. This section provides an overview of some of the major theories of learning that have evolved since the early 1900s.

Behaviourism

- Internal mental states were deemed to be not observable and therefore of little interest
- The focus was on external behaviours which could be observed and studied
- Learning is seen as the acquisition of new or changed behaviour in response to stimuli from the external environment – called "S-R bonds or connections"
- Two main proponents were Thorndike and Skinner who developed various techniques based on positive and negative reinforcement. These techniques are still considered to be sometimes effective.

Cognitivism

- Association between learning and internal mental processes became recognised
- Learning is seen as the acquisition of knowledge – the organisation of this knowledge is the central characteristic of cognition[2] (learning)
- The emergence of computers influenced the development of cognitivism - learners were perceived as information processers taking information in from the external environment, performing cognitive operations on it and storing it in memory for later use
- Teachers were central to the learning process and textbooks and lectures were viewed as the preferred method of instruction
- Students were passive recipients of knowledge.

[2] Cognition is the scientific term which refers to the mental processes involved in gaining knowledge and comprehension, including thinking, knowing, remembering, judging and problem solving.

- Key figures in the development of cognitivism as a theory of learning included Jerome Bruner and Howard Gardner - both American and both psychologists, and Jean Piaget, a Swiss psychologist
- Bruner recognised the links between society, economy and education – *"what we resolve to do in school only makes sense when considered in the broader context of what the society intends to accomplish through its educational investment in the young."*

Constructivism

- The constructivist learning model asserts a move from knowledge acquisition (cognitivism) to knowledge construction
- The central tenant is that learners actively construct their own knowledge mainly by organisation of their own mental structures
- Learning is seen as a personal endeavour which is affected by the learning context as well as the attitudes and beliefs of the learner. Motivation is a key driver for learning
- Constructivism sees a shift away from the teacher-centric learning towards student-centric learning
- Teachers place a reduced emphasis on textbooks and traditional 'chalk-and-talk' techniques, and place a greater emphasis on guiding student learning through the use of carefully crafted lessons. Lessons are characterised by engaging activities that promote active learning
- The writings of Piaget, Vygotsky, along with the work of John Dewey, Jerome Bruner and Ulrick Neisser are considered to form the basis of the constructivist theory of learning and instruction
- In the context of Leaving Certificate Computer Science, it is worth noting that constructivism has particular relevance in learning tasks where it is important for the learner to find new ways of dealing with old problems. One of the key challenge faced by Phase One teachers will be to provide students with problems that support this type of learning.

Social Constructivism

- This theory of learning is an extension of constructivism which recognises the social nature of knowledge
- Social constructivism stresses the importance of context ("situated learning") and the role of interpersonal interactions in the development of cognition
- One of the main exponents of Social Constructivist theory was Lev Vygotsky (a Russian psychologist and contemporary of Piaget) who perceived human development in a broad social context and asserted that individual mental processes stem from social processes.
- Phase One teachers could reflect on these key features of social constructivism and the potential to embed this approach into Leaving Certificate Computer Science. In particular, it may be worth reflecting on the how this model of learning might be used in Strand 3: Computer Science in Practice, and the roles and relationships that will need to be developed among students in order to carry out the Applied Learning Tasks in groups.

Metacognition

Although it is not considered a separate standalone model of learning per se, educational psychologists have long promoted the importance of metacognition for regulating and supporting student learning. More recently, the Partnership for 21st Century Skills has identified self-directed learning as one of the life and career skills necessary to prepare students for post-secondary education and the workforce[3].

Learners who have been taught metacognition have the skills to realise the limitations of their own knowledge, recognise when they are 'stuck' on a problem, and are equipped with strategies for addressing unfamiliar challenges. In the words of Guy Claxton metacognition is about, "*knowing what to do when you don't know what to do*."

The relevance of metacognition to the teaching and learning of Leaving Certificate Computer Science should require no further explanation.

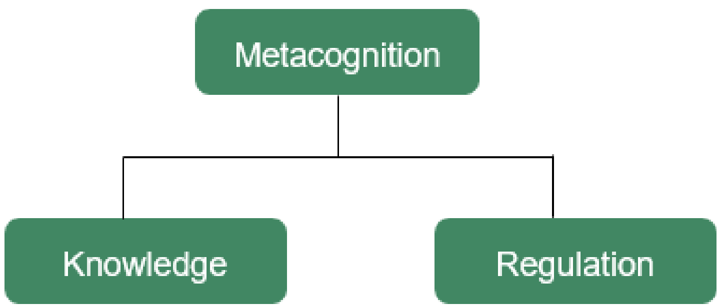
[3] Source: Metacognition: A Literature Review, Research Report, Emily R. Lai, April 2011

So, what is metacognition?

Metacognition refers to our own knowledge about our own learning processes. The term was initially coined by John Flavell in the late 1970s. Since then many definitions have emerged of which "thinking about thinking" is probably the most widely used. This phrase derives from Flavell's original definition – "cognition about cognitive phenomena".

Since metacognition is effortful, it is sometimes referred to as 'thinking out loud' or 'making thinking visible'.

Metacognition is generally considered to have two components – metacognitive knowledge and metacognitive regulation.



Metacognitive knowledge includes knowledge about oneself as a learner and about the factors that might impact performance (declarative), knowledge about strategies (procedural), and knowledge about when and why to use strategies (conditional).

Metacognitive regulation is the monitoring of one's cognition and includes planning activities, awareness of comprehension and task performance, and evaluation of the efficacy of monitoring processes and strategies

In summary, metacognition is knowledge and understanding of what we know and how we think including the ability to regulate our own thinking as we work on a task.

Metacognition is something most of us engage in every day, albeit very often at a sub-conscious level. When faced with a new task or challenge metacognition enables us retrieve, adapt and deploy a relevant strategy from some previous, but similar context.

Why is metacognition considered important?

One of the reasons for seeing metacognition as increasingly important nearly 30 years after it was first coined in education is because we're just now approaching implementation of the new agenda of *personalisation*. The personalised approach to education, at its best, will see learners actively involved in planning and managing their own learning goals. The ability to reflect on what and how one has learned, and then to implement plans for self-development, will be critical to learners' personal success. Teachers need to be able to promote the young people in their care to become more reflective and self-evaluative, and to be able to recognise that when learning gets tough, they have strategies for tackling it[4].

The main benefit of metacognition for learners is that it improves their abilities to learn. This stems from the fact that metacognition empowers students giving them a greater sense of ownership and control over their own learning. This in turn, leads to more enjoyable learning experiences, better learning performances, and higher levels of academic achievement.

Furthermore, research[5] informs us that metacognitive skills are beneficial to all students including students having special educational needs as well as those with exceptional abilities. The same research shows that students tend to attribute success to good luck and failures to lack of ability. By teaching metacognition such faulty mental models, and consequential feelings of helplessness on the part of students can be addressed and discredited.

From a teacher's perspective it is important to be aware that metacognition (metacognitive skills) can be taught. Because metacognition plays a critical role in successful learning, it is important that students are provided with an opportunity to learn about metacognition and develop their metacognitive abilities. An understanding of students' metacognitive abilities has the potential to inform the practice of teaching, especially in areas such as lesson planning, and task design and selection.

[4] Source: Teaching and Learning in Further and Higher Education: A Handbook by the Education for Employment Project (McAney et.al., 2007)

[5] Source: Metacognition for the classroom and beyond: Differentiation and support for learners (Special Education Support Service, September 2009)

Relevance to LCCS

Since metacognition is relevant to all thinking and learning, it follows naturally that it can be applied to all curricular subjects. The relevance of metacognition is especially true for the Leaving Certificate Computer Science curriculum – in fact, it could be argued that certain aspects of the curriculum that are particularly rich in potential for Phase One teachers to elicit metacognitive behaviour in their students. Included among these are areas such as:

- Computational Thinking (S1
- Designing and developing (S1)
- Evaluation and testing (S2)
- Social and ethical considerations of computing technologies (S2)
- User-centred design

By its own very nature, the art of computer programming will require students to frequently shift their perspectives between that of the programmer, and that of the 'imaginary' end-user for whom an artefact is being developed. It is difficult to see how this could be best achieved without an explicit understanding of metacognition.

The same could also be said for any of the other roles assumed by students they work together in groups to complete the four Applied Learning Tasks.

The relevance of metacognition and models of learning to Leaving Certificate Computer Science are perhaps best captured in the following extract[6] – *"The current understanding of learning, aimed at promoting 21st century or "adaptive" competence, is characterised as "CSSC learning": "constructive" as learners actively construct their knowledge and skills; "self-regulated" with people actively using strategies to learn; "situated" and best understood in context rather than abstracted from environment; and "collaborative" not a solo activity."*

[6] Source: Historical developments in the understanding of learning (Erik de Corte, 2010)

How can teachers promote metacognition in the classroom?

There appears to be consistency throughout the literature[7][8] that there a four to five ways to increase metacognition in classroom settings. These can be summarised as follows:

1. Explain the concept of metacognition – what it is and why it is relevant and important
2. Show students what metacognition looks like by modelling it in our own work as teachers and giving students opportunities to "think aloud" as they work their way through problems.
3. Provide students with a set of strategies, explaining to them when, why and how they could be appropriately used. Examples of general pedagogic strategies[9] such as KWHL, Mindmaps, SQ3R along with other more domain specific active learning strategies such as PBL, TPS, Pair Programming, Peer Instruction and PRIMM are widely documented.
4. Create an environment and culture that supports metacognition by acknowledging instances of its use. Allot time for students to plan, monitor and evaluate their own work in a journal.
5. Assist students in metacognitive regulation. This can be done initially, by providing a set of guiding questions for students (see below) to use as a checklist every time they are given a problem to solve or task to complete. Ideally students should eventually devise their own guiding questions specific to their own individual needs.

Planning:

1. Does the task make sense to me (or do I need to seek clarification)?
2. Can I *imagine* a possible answer/answers to the problem (not a solution)?
3. What do I already know that might be relevant? How does this exercise link in with earlier material covered?
4. What should I do first?
5. What resources are available to me? How much time do I have?
6. Can I solve a similar (more manageable) problem?

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[7] Promoting general metacognitive awareness, (1998, Schraw)

[8] Increasing the metacognitive awareness of high school students (2013, McFarland)

[9] For a good starting point see http://www.pdst.ie/sites/default/files/Integrated%20Approach_0.pdf

Monitoring

1. Do I have a clear understanding of what I am doing?
2. What strategies am I using? Are they working well?
3. Can I spot any patterns? Can I make any assumptions or generalisations?
4. What strategies have I used in the past when I encountered a problem?
5. Do I need additional resources?

Evaluation

1. Have I reached my goal?
2. How do I know my solution is correct?
3. Is my solution correct all the time (or does it just work sometimes)?
4. Are there any alternative ways to solving this problem?
5. What would I do differently if I have a task like this in the future? What have I learned?

Conclusion and teacher tips

Research evidence points to the fact that metacognition leads to significant improvements in learning. Metacognition has particular relevance to Leaving Certificate Computer Science and is too important to ignore. Teachers should:

- build metacognitive time into the learning process
- pose questions about thinking and feeling and allow students ample time to reflect on their own learning
- encourage students to document their thoughts somewhere e.g. journal/wiki/blog/VLE etc.
- model their own thoughts out loud on a consistent basis – don't be afraid to model mistakes
- set timelines and adhere to them
- honour diverse learning styles and perspectives
- challenge their own assumptions and trust the research.

Metacognition and Models of Learning

Metacognition	Cognition about cognitive phenomena
Social Constructivism	Knowledge is constructed collaboratively
Constructivism	Knowledge is constructed
Cognitivism	Information is processed
Behaviourism	Stimulus-Response bonds

Notes

Why is Metacognition Important?

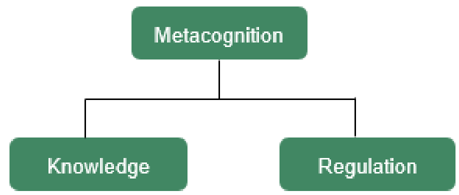
- Gives students a sense of control over learning
- Teaches students how to learn
- Helps to promote “deep learning”
- Applicable to all students and all subjects
- Particular potential in LCCS

“Metacognition improves student performance”

Notes

What is Metacognition?

Knowledge and understanding of what we know and how we think, including the ability to regulate our thinking as we work on a task



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Notes

Techniques to Promote Metacognition

1. Explain it and model it
2. Improve student's knowledge of cognition
3. Help students to learn to regulate their thinking as they work on a task
4. Foster learning environments that value and promote metacognitive awareness

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Notes

Reflection

Think back on the section just complete and attempt to answer the following questions.

What one question are you still thinking about in relation to this topic?

What two ideas about metacognition resonated with you?

What three questions can you compose that might help promote metacognitive self-regulation?

Metacognition in Action

The purpose of this section is to model the metacognitive processes that take occur when a problem is being solved. Research tells us that once students understand what metacognition is, they are more likely to develop and use their own metacognitive skills if they witness it being practiced on a regular basis in the classroom.

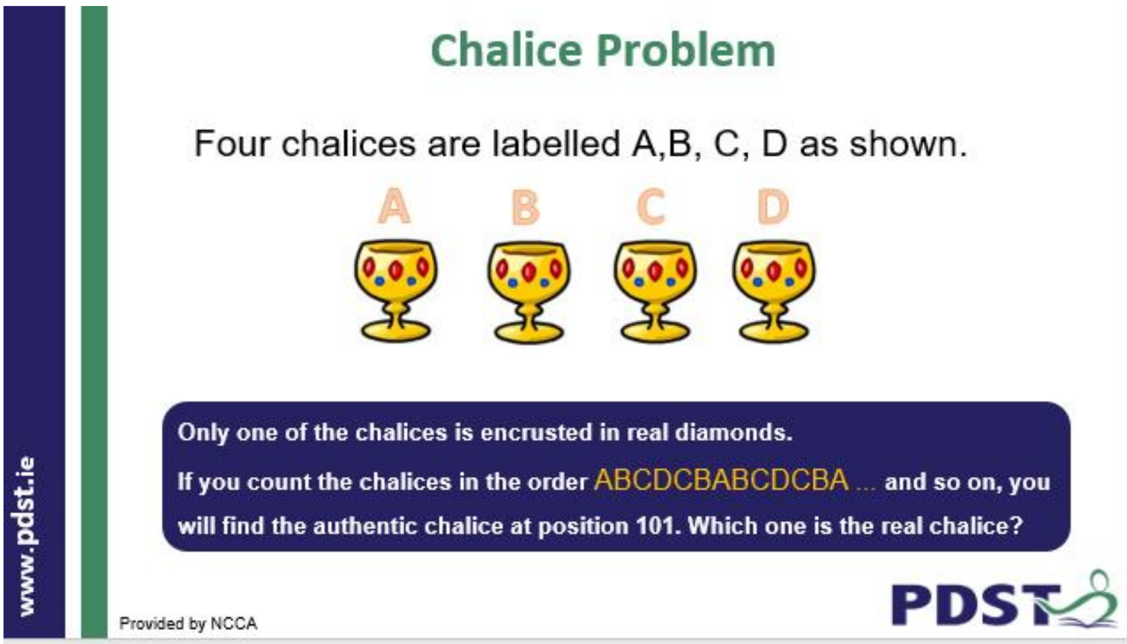
Recall that metacognition is effortful. For this reason, it is sometimes referred to as 'thinking out loud' or 'making thinking visible'.

Participants are requested to listen carefully noting the metacognitive behaviour and, in particular, any questions posed by the presenter during the demonstration.

What three questions were asked that captured your attention during this demonstration?

The Chalice Problem

Attempt to solve the problem below logging your thoughts as you proceed. You may find it helpful to use some of the questions you noted from the previous section or the guiding questions provided earlier – however, it is best if you can devise your own questions.



Bear in mind that this is an exercise in 'thinking about thinking'. There is no expectation on anyone to come up with a solution. The important thing is to note your thoughts as you proceed.

Notes/Thoughts/Questions

Guiding Questions

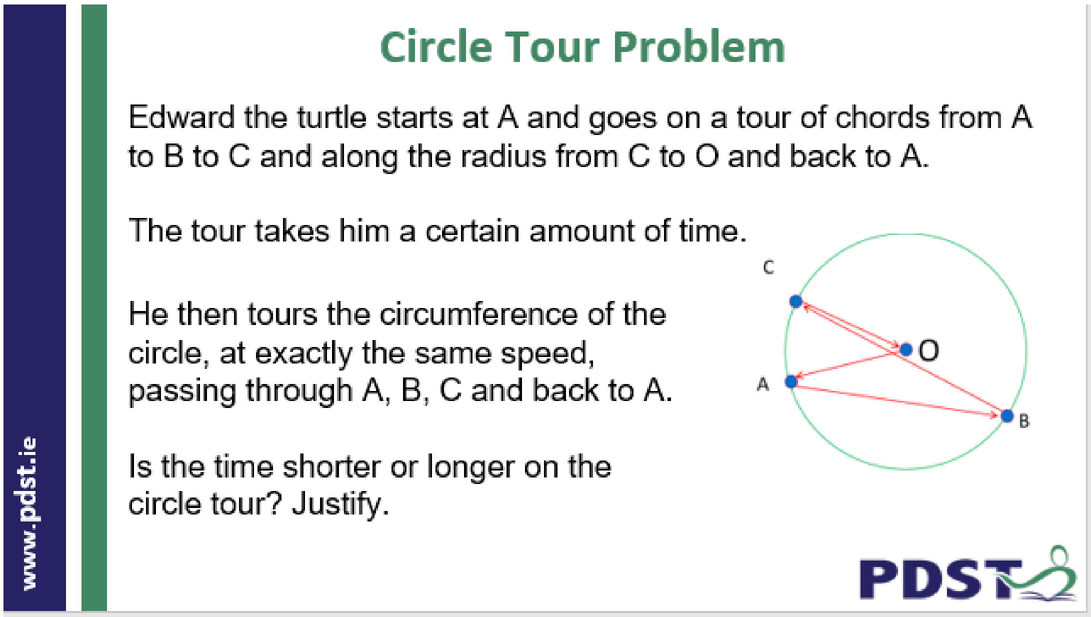
The questions below provide additional scaffolding to help you develop your metacognitive skills as you work your way through the chalice problem. You don't necessarily have to address each question - they are intended to be supportive rather than prescriptive. Remember, the purpose is to experience problem solving from a learner's perspective.

- Where should I start? Can I paraphrase the problem in my own words or with a diagram?
- Can I simplify the problem? If I break the problem down to a small number of chalices at first will that make the problem easier to solve?
- Would it help to label the chalices with numbers and start counting?
- Can I see any patterns in the sequence of chalices? If so, can I use these patterns to make predictions?
- If I get stuck is there anywhere I can turn to for help?
- If I find an answer how can I verify it is correct?
- What if the real chalice was at position 100? 1000? Would my solution still work?
- What have I learned?

Notes/Thoughts/Questions

Circle Tour Problem

In this section participants will work in teams as observers or solvers. Ideally there will always be more solvers than observers. The solvers work out loud and the observers log metacognitive traits of their process.

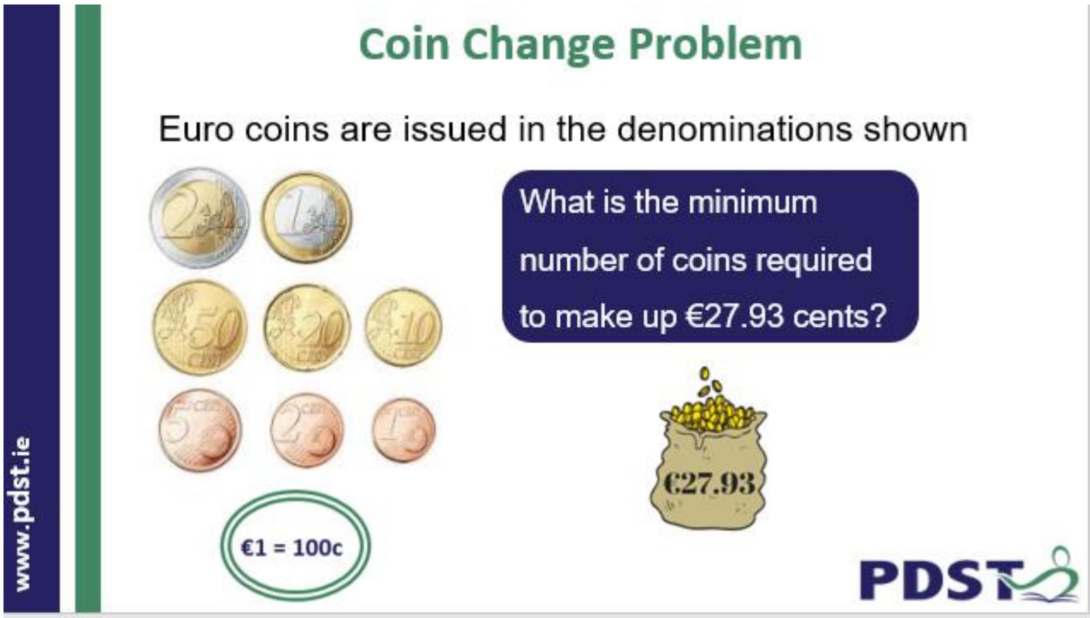


Rough Work

Observations on metacognition

Coin Change Problem

This time the roles are reversed i.e. if you were an observer for the previous problem you become a solver for this one and vice versa.

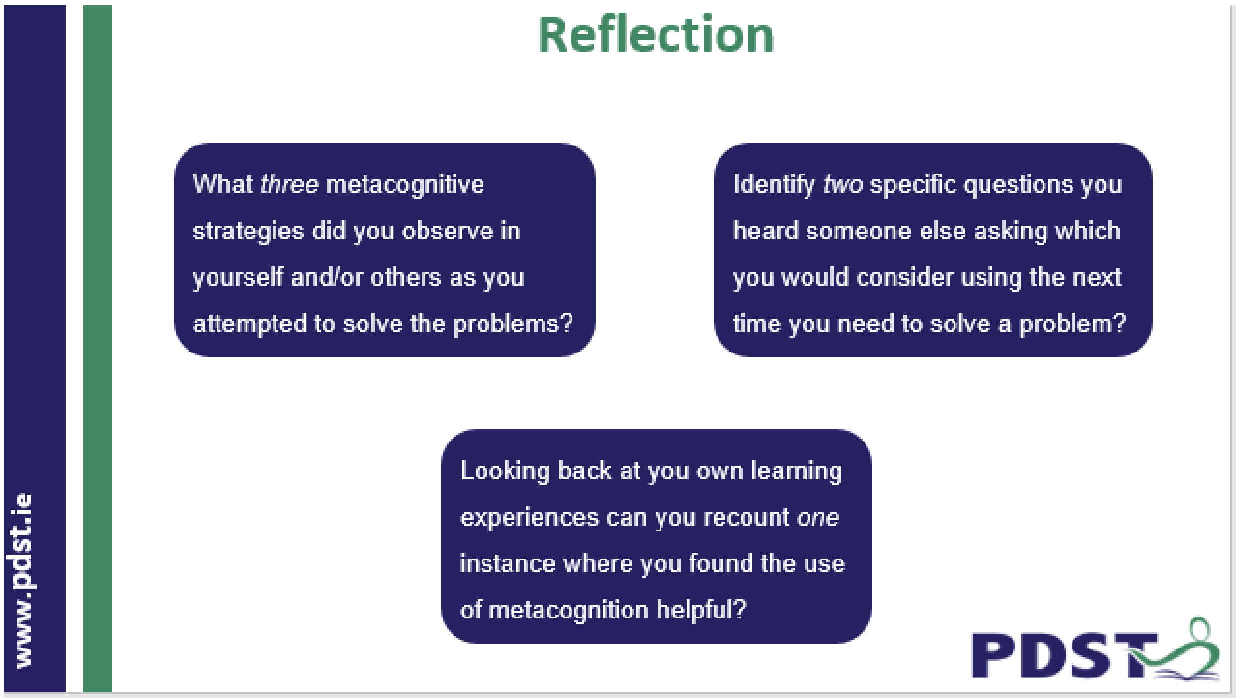


Rough Work

Observations on metacognition

Reflection

Consider the following questions in the light of this session



Reflection

And finally ….

The intention behind this section is to provide an insight into the type of questions and answers that a student may pose in tackling the circle tour and coin change problems. It should be noted that different students may approach the same problem in different ways. What is important is that there is an awareness of one's own metacognitive processes as one attempts to solve a problem.

Circle Tour Problem

Q. Where should I start?

A. I always find it useful to start by writing my own thinking. I use pen and paper to jot down a visualisation of the problem. In this case I will draw a number of diagrams to represent the movements of turtles around different sized circles?

Q. What prior knowledge about circles do I already have?

A. I understand the terms circumference, radius, diameter and chord, and understand the mathematical relationships between them. I know the formula for the area and the circumference. I can also remember a lot of theorems related to the circle which I can look up if needed. I can jot this information down with pen and paper as I proceed.

Q. What is the question looking for?

A. The question is asking which of two routes – ABCOA and a circumference – can be travelled in the shortest time. The answer will be one of these routes.

Q. How can I measure the amount of time it takes to travel both routes?

A. I have no way to measure time as this is an abstract problem (as opposed to a real life simulation).

Q. I seem to be stuck – what am I missing? What else do I know about time?

A. I know that time is related to distance and speed. The questions states that the speed is constant so the variable must be distance. I need to calculate the distance of both routes – the longer route will take more time than the shorter one. This will lead me to an answer.

Q. What is the length of circumference?

A. $2\pi r$ This is approximately 6.28 radii.

Q. What is the length of the path ABCOA?

A. Since my previous answer was in terms of radii, I will attempt to express this length in terms of radii also. The paths AB and BC are both chords. CO and OA are both radii – together they make up a distance of 2 radii.

Q. What is the length of the cords?

Since dimensions have not been provided I must infer an answer. I know the longest chord in a circle is the diameter. Thus the maximum possible length of a chord is 2 radii in length. So the 2 chords from A to B, and from B to C, cannot be longer than 4 radii in total.

Therefore, the maximum possible distance of the path ABCOA is 6 radii.

I can conclude that since the journey along the circumference is more than 6 radii it will take more time than the journey along the chords and radii.

Answer: The journey around the circle takes a longer time than the journey across the chords and the radii.

Q. How can I verify that I am correct?

By choosing different values for the radius I make some calculations to compare the journeys and verify that my answer is correct using concrete examples.

It is interesting to observe that the solution does not depend on any particular value of the radius. In other words, this is a general solution that will work for any sized circle.

Coin Change Problem

Q. Can I make this problem any easier?

A. Yes. I could start with €5 and then look at €25 and then €27 – this approach will put me on the right path.

Q. What is the minimum number of coins required to make €5?

A. I know the answer is 3 coins – 2x€2 and1x€1 but how do I know this? What am I doing here?

I start by dividing 5 by 2 as this is the largest denomination - $5 \div 2 = 2$. The remainder is a single euro. I note to myself that a single euro would be left over for all odd whole amounts. €25 breaks down in using the same method - $25 \div 2 = 12$ plus the single leftover euro, giving a total of 13 coins. Similarly, €27 is made up of 13 two euros plus an additional euro.

Q. So what is my method?

A. I simply divide the whole amount by two and add the remainder which could be either zero or one. This gives me the total number of coins that make up that amount.

Q. What about the decimal part? How can I break down 93cents?

A. I know there is 1x50cents + 2x20cents + 1x2cents +1x1cent – a total of 5 coins.

Q. Again, can I describe my method for decimals?

A. I first divide by 50 and remember the answer – call it *ans1*

I then divide the remainder by 20 and again remember the answer – call it *ans2*

If I keep going like this divide each remainder by the next lowest denomination (from ten down to two) and add up all my answers (ans1+ans2 etc.) plus the remainder from the final division by two I will have the number of coins required to make up the decimal part.

Q. So can I put it all together?

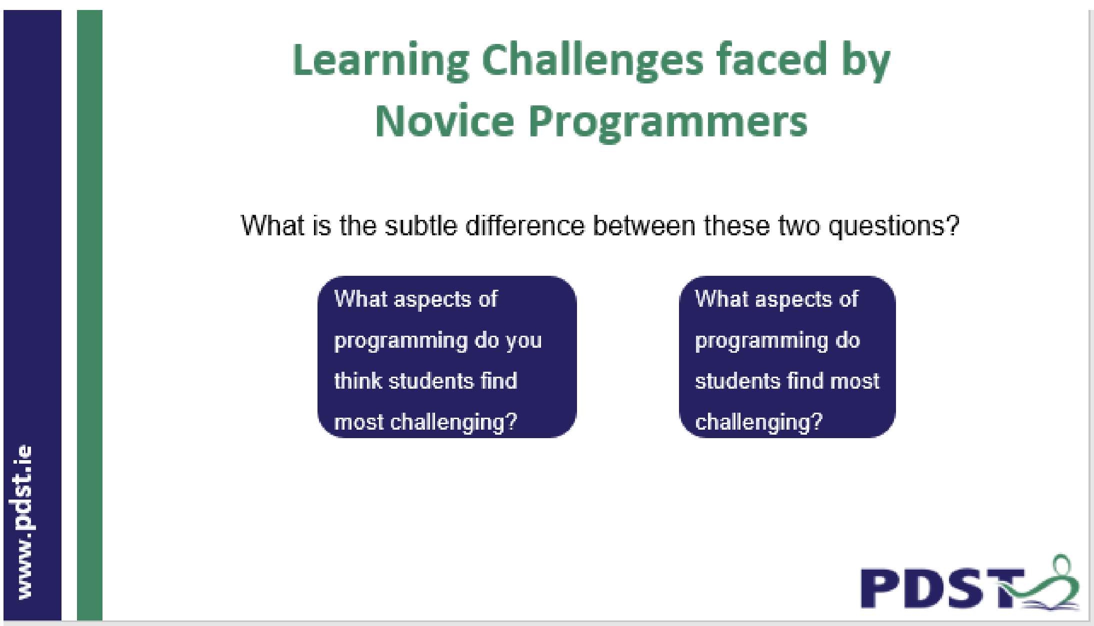
A. Yes. Just split the amount into a whole part and a decimal part and apply the two methods described. My answer is it takes $14 + 5 = 19$ coins to make up €27.93.

Session 4: From a learning to a teaching perspective

In this session we will be changing our viewpoint of learning. Over the course of the session the focus of our attention will shift slowly away from ‘learning through the lens of a student’ and gradually move towards the implication for teachers of the thi ….

We will start by exploring the learning challenges faced by novice programmers and then take a look at what the research has to say on the topic.

But before we get started take a look at the following slide. Can you spot the subtle difference between the two questions?



Notes

Learning Challenges faced by Novice Programmers

Personal account of learning how to program.

Notes

Use the space provided on the next page to answer the two questions shown.

You may find the following questions useful to guide you:

- What was the first programming language you learned?
- If you ever learned a second programming language how did the learning experience differ the second time around?
- Did you ever have that Aaahhh!! moment?
- Were there any programming constructs you found particularly difficult/easy to grasp?
- What was the balance between theory and practical?
- What were the practicals like?
- What approach was taken by your teachers?
- What was the nature of your learning?
- In what ways might Computer Science differ from other subjects in terms of learning (later we can ask the same question in terms of teaching)

How did you learn how to program?

What were the main challenges for you?

Research into Learning Challenges[10][11] [12]

Computer Programming is widely regarded as a difficult subject to learn. The relatively high non-progression rates for many third-level computer science courses have been widely reported on in the media and are a source of ongoing concern for Higher Education Institutions (HEIs) and policy makers alike. The introduction of computer science as a leaving certificate subject and, in particular, the pedagogic approach used to teach it have the potential to have a positive impact on HEI student progression rates.

So, why is programming considered to be so challenging?
Programs by their very nature are abstract. The objective of a program is very often to model some real world phenomena on a machine. Programming students are likely to be presented with a wide variety of problems and the required understanding, strategies and skills in order to solve them. Furthermore, once a student understands how to solve a particular problem manually (and verify that their solution is correct) they must be able to create a general solution and then translate this (natural language solution) into a programmatic solution. This requires not only an understanding of the syntax and semantics of a programming language but also the development tools and the underlying execution environment. There can be a lot going on! This can lead to 'cognitive overload'.

The precision demanded by language syntax can often cause difficulties for students. Specifically, programming constructs such as variable initialisation, loops, conditions, recursion, pointers/references, arrays and abstract data types are among the most commonly reported problems. (Not all of these constructs are on the LCCS curriculum.) Students find expressions that are syntactically close to each other but mean different things confusing e.g. the difference between the string "123" and the integer 123. It is worth noting that teachers tend to give high levels of instruction and feedback on these 'low level issues' and students tend to respond well and overcome the issues in most cases.

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[10] Learning and Teaching Programming: A Review and Discussion (2003, Robins et. al.)
[11] A study of the Difficulties of Novice Programmers (2005, Lahiten et. al)
[12] Problems in Learning and Teaching Programming (Kirsti Ala-Mutka)

However, research reports that the main source of difficulty for novice programmers seems to be related to ‘high level’ or ‘big picture’ issues. These are issues which required students to understand larger entities of a program and not just some syntactic details about the individual lines. Specific examples of these issues include program design, dividing functionality into procedures and finding bugs. Other more specific examples include the use of language libraries, object-oriented concepts and error handling. Unfortunately, the research reports that many teachers tend to give low levels of feedback on these ‘high level’ issues.

The application of programming constructs to program construction is another major source of difficulty. While students may understand the syntax and semantics of individual statements very often they do not know how to combine them into larger programs. Students have problems in understanding that each instruction is executed in a particular state that has been created by the previous instructions.

It is interesting to note that teachers perceive similar difficulties for novice programmers to those outlined above. One key difference however was that teachers rated the difficulties on average higher than students. This informs us that students often perceive their own programming proficiency to be greater than it actually is – a fact that can exacerbate the challenges faced by novice programmers.

A number of students reported difficulties in transferring the ways they learned in other subjects to their programming subject. One possible explanation for this is the fact that rote learning is near impossible in the programming context[13]. It is anticipated that for many Phase One LCCS students programming will be a new discipline. For these students the art of programming will be new and unfamiliar. Problem solving skills and strategies may as yet be undeveloped and an awareness of metacognition may be completely absent. Phase One teachers will need to be aware of the need to combine both subject content knowledge with pedagogic strategies that are appropriate to the disciplines of computer science and computer programming.

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[13] Learning challenges faced by novice programming students studying high level and low level feedback concepts (2007, Butler and Morgan)

Student Challenges – low level issues

Variables

Assignments

Arrays

Basic Programming Constructs e.g. loops, conditions

Pointers and References

Recursion

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Notes

Student Challenges – high level issues

Understanding program development environment

Program Design

Dividing functionality into procedures

Debugging

Higher Level Programming Constructs (libraries , files i/o etc.)

Students can understand syntax but find it difficult to construct programs

Application

Perceptions

Differences with other subjects

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Notes

High School Scenario

Read the scenario[14] below and answer the question that follow.

The technology department at our high school currently offers computer programming, web page design, and audio production classes. These classes are considered electives, and are usually comprised of 15-24 students with the grade level ranging from freshman to senior. During the course of the semester, students are presented with a series of increasingly difficult concepts related to the subject. Related concepts, when possible, are grouped together – or chunked – in an effort to make it easier for the students to organize and remember the information. In order to maintain consistency in the classroom, each concept is presented in a similar fashion. First, the previous concept is reviewed in order to ensure its understanding. Students are then given a handout that lists the concept and provides a standardized format for note taking during the discussion portion of class. The handout, if completed by the student, is designed to serve as a reference during the completion of practice and graded projects. Next, the new concept is described and discussed, students are asked how it relates to the previous concept, and how they think it might be utilized in their projects. *LanSchool* – the classroom management software – is used to broadcast examples of the concept to each student monitor. During this demonstration, typical problems that students have encountered in the past are identified. These mistakes are highlighted in an attempt to help current students avoid similar situations or circumstances. The lesson ends with a summary and a question and answer session. After any misunderstandings have been addressed, students are given the remainder of the class period in order to examine and explore the new concept and its interaction(s) with the previous concepts. Once two or three new concepts have been presented, a practice – or formative – project is completed, and then a graded – or summative – project is assigned to assess student learning. To ensure the utilization of the presented concepts, students are given the technical requirements for each graded project, and to encourage creativity, students usually have the option of choosing their own topic or content. Due to the cumulative nature of the class, successive projects become more complex as they incorporate not only the new concepts, but each previous one as well.

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[14] Source: Increasing the metacognitive awareness of high school students (2013, McFarland)

During the completion of these projects, many of the students:

1. Lack organizational and time management skills.
2. Do not exhibit any creativity or imagination.
3. Are not detail oriented, do not take notes, or ask questions.
4. Are not able to clearly communicate their thoughts and ideas.
5. Exhibit characteristics of learned helplessness insomuch as they proclaim, “I can’t do this,” when their first attempt is not successful.

What teaching strategies could be used to address the issues highlighted?

Teacher Challenges and Strategies

In future CPD we will explore challenges (faced by novice programmers) from a teacher's perspective and examine some of the successful strategies as reported by teachers from other jurisdictions[15]. Some of the key areas to be looked at include:

- Unplugged type activities
- Contextualisation of tasks
- Collaborative learning
- Developing Computational Thinking
- Scaffolding Programming Tasks
- Tasks that elicit Metacognitive Behaviour

Another area worthy of discussion is that of developing student resilience in relation to computer science and in particular computer programming.

Notes

[15] Computing in the curriculum: Challenges and strategies from a teacher's perspective (2016, Sentence and Csizmadia)

Tasks to elicit metacognitive skills

Well designed tasks have the potential to leave students with a powerful impression of learning. Carbone et. al.[16] lists the following 10 design principles to be considered when formulating programming exercises to improve student learning.

1. Design tasks with aims, but allow students to be rewarded for experimentation and exploration. This should discourage students giving up when a wrong result is achieved.
2. Design tasks that require students to record and monitor their activities to discourage laziness and lack of motivation settling in
3. Avoid giving students programming exercises for which solutions can be directly copied from the notes
4. Avoid tasks that give step-by-step instructions on how to complete a task; students should have the opportunity to develop a plan and experiment
5. Look for opportunities to show students that successful programming requires more than following step by step instructions.
6. Build into programming tasks opportunities for students to openly discuss plans of attack
7. Design tasks that require the logging of errors encountered, possible explanations and suggestions for fixes
8. Allow students to report on unpredictable problems that have been encountered, and their understanding of nature of the problem
9. Design tasks that reward students for discovering interesting "technical" insights
10. Design tasks that require students to reflect, discuss and analyse their own learning

Using the above questions to assess a selection of the tasks listed on the following pages in terms of their potential to elicit metacognitive behaviour and improve student learning.

[16] Design principles for programming tasks to elicit metacognitive behaviours in first year students (2002, Carbone et. al)

Task 1

Key in the two programs below and use them to verify that 1900 was *not* a leap year but 2000 was. One of the programs is incorrect? Which one? Can you fix the error?

```
# User enters the year
year = int(input("Enter Year: "))

# Leap Year Check
if year % 4 == 0 and year % 100 != 0:
    print(year, "is a Leap Year")
elif year % 400 ==0:
    print(year, "is a Leap Year")
elif year % 100 == 0:
    print(year, "is not a Leap Year")
else:
    print(year, "is not a Leap Year")
```

```
# User enters the year
year = int(input("Enter Year: "))

# Leap Year Check
if year % 4 == 0 and year % 100 != 0:
    print(year, "is a Leap Year")
elif year % 100 == 0:
    print(year, "is not a Leap Year")
elif year % 400 ==0:
    print(year, "is a Leap Year")
else:
    print(year, "is not a Leap Year")
```

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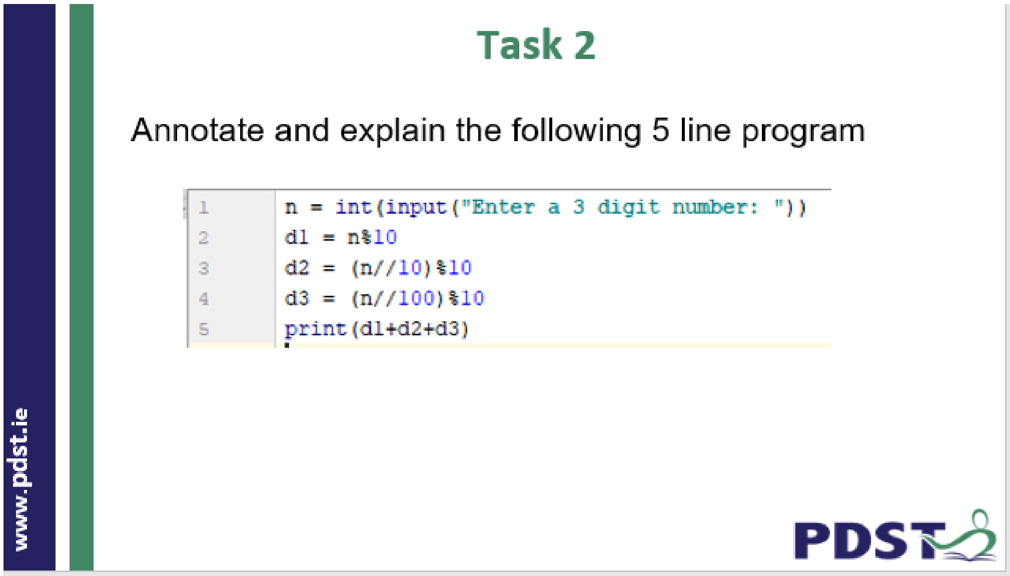
Task 2
Annotate and explain the following 5 line program
n = int(input("Enter a 3 digit number: "))
d1 = n%10
d2 = (n//10)%10
d3 = (n//100)%10
print(d1+d2+d3)
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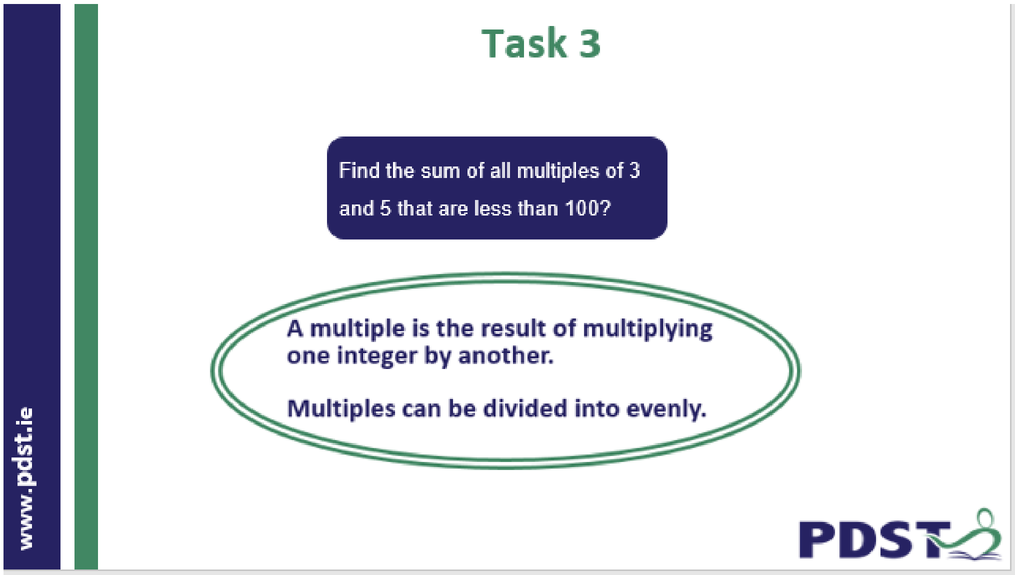
Notes


Task 3
Find the sum of all multiples of 3 and 5 that are less than 100?
A multiple is the result of multiplying one integer by another.
Multiples can be divided into evenly.
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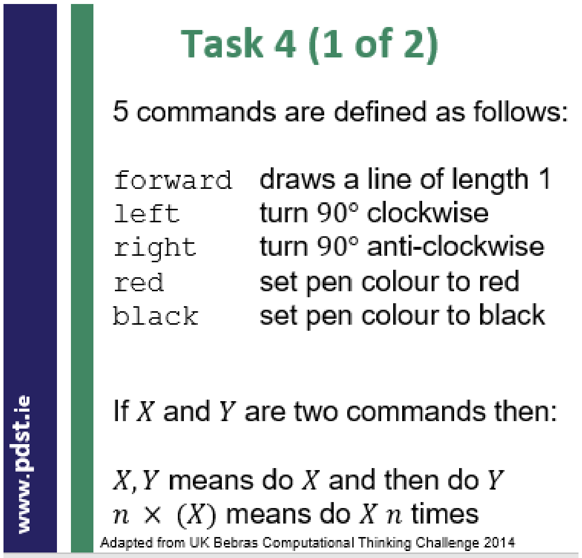
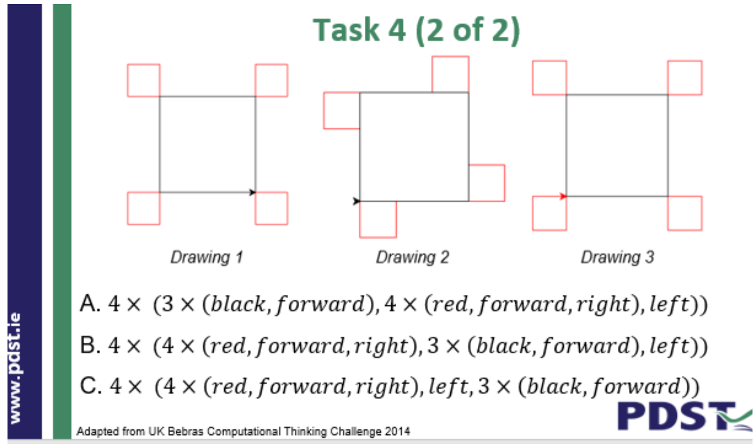
Notes





Notes

Match the shapes to the commands.

Task 5

Which of the following three programs do you prefer and why?

```python
# Program 1 to compute 5!
answer = 1
counter = 5
while (counter > 0):
    answer = answer * counter
    counter = counter - 1

print(answer)
```

```python
# Program 3 to compute 5!
answer = 1
for i in range(1, 6):
    answer = answer * i

print(answer)
```

```python
# Program 2 to compute 5!
def factorial(n):
    if n == 1:
        return 1
    else:
        answer = n * factorial(n-1)
        return answer

print(factorial(5))
```

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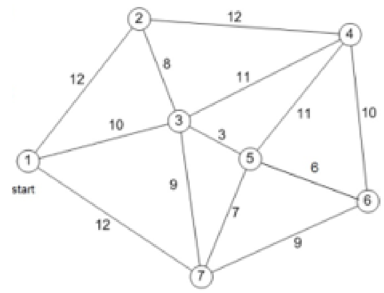
Notes

Task 6

Given a list of cities and the distances between each pair of cities, what is the shortest possible route that visits each city and returns to the origin city?"



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Notes

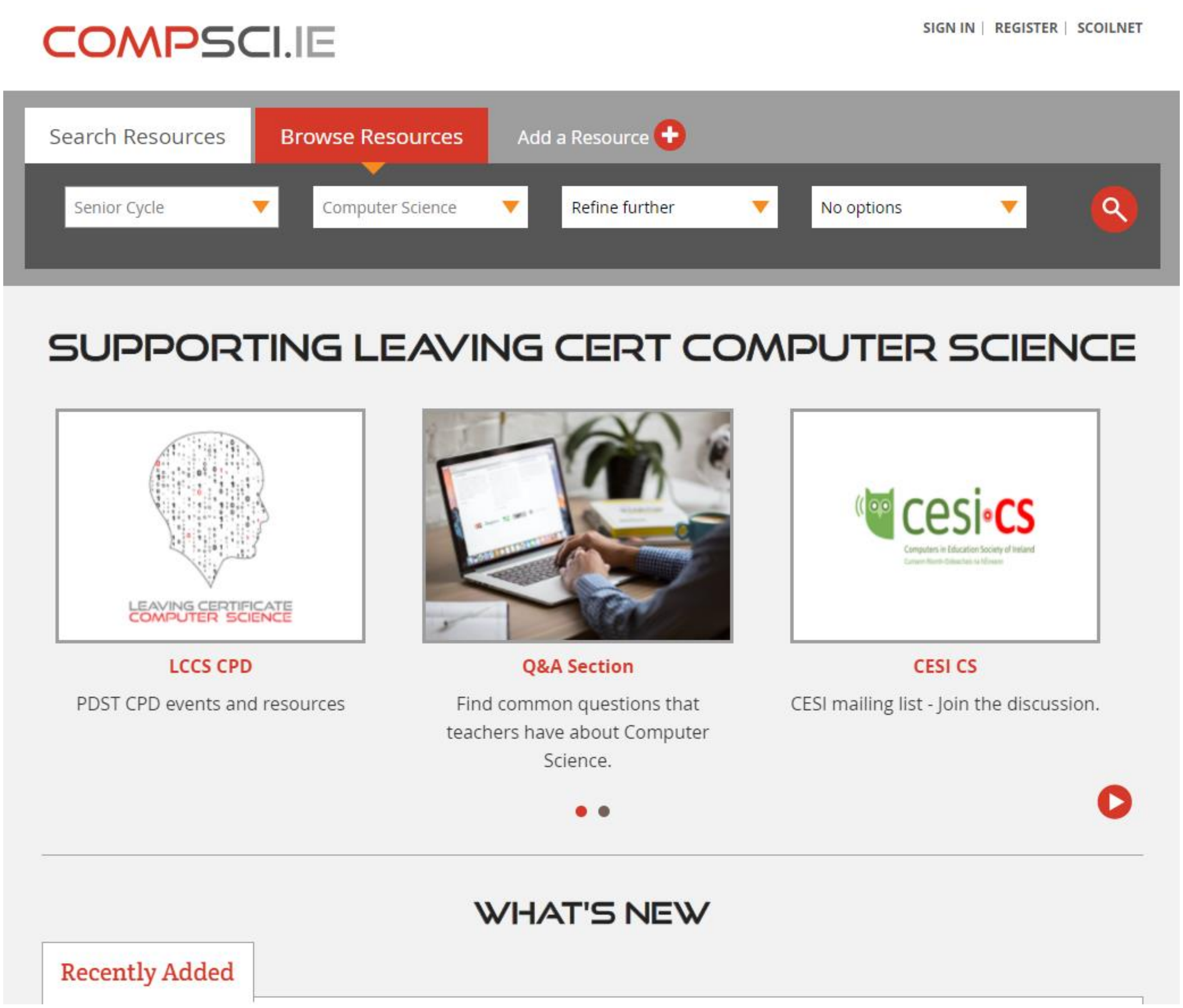
The table below highlights the features of programming tasks that discourage metacognitive behaviours in students.

Feature of task	Intended student behaviour by lecturer	Student behaviour
Solution to exercise can be directly copied from the notes	Expects student to refer to notes for clarification purposes only	Copies directly from notes
Tasks that give step-by-step instructions	Expects students to follow steps, and experiment afterwards	Little opportunity to plan and experiment
Tasks that don't require students to record and monitor their activities	Expects students to consider what they are doing and why	Laziness and lack of motivation may settle in
Tasks that don't require the logging of errors encountered, possible explanations and suggestions for fixes	Expects type and cause of error is understood	Interesting insights are ignored and seen as time wasting lessons, nothing valuable to be gained.
Tasks that don't require students to report on unpredictable problems	Expect students to explore the problem	Lack of understanding of nature of the problem
Tasks that don't reward students for discovering interesting "technical" insights	Expects students to take a life-long learning approach, discovering technical insights to be competent programmer	Ignores the value in understanding the problem and ways to fix it
Tasks that don't encourage and reward experimentation	Expects students to explore and be engaged	Treats task as a hurdle requirement
Task or equipment contains an unintentional problem or error.	Expects students will take this in their stride and still focus on key ideas	Key ideas completely lost. Very high level of frustration, angry and loss of motivation settle in.
Does not prompt student to discuss plan of attack	Analyse different approaches to tackling a problem	Does not collaborate or see need to reflect on approach adopted

Can you devise features of programming tasks that would encourage metacognitive behaviours in students?

Resources

All PDST Computer Science resources are available publically for everyone to download from http://www.compsci.ie/



All phase one teachers are encouraged to develop and share their own resources for Leaving Certificate Computer Science.

Teachers must register a new account in order to be able to share/upload their resources. A Teaching Council number and School Roll number are required in order to complete this process.

The resource structure headings which are based on the specification are shown below for information.

S1. Computational Thinking

- Problem Solving

S1. Computers and Society

- Social and Ethical considerations
- Turing Machines
- The Internet
- Artificial Intelligence
- User-centred design

S1. Designing and Developing

- Design process
- Working in a team
- Communication and reporting
- Software development and management

S2. Abstraction

- Abstraction

S2. Algorithms

- Programming concepts
- Sorting
- Algorithmic complexity

S2. Computer Systems

- Computer components
- Basic electronics
- Operating System layers
- Web infrastructure

S2. Data

- Data types
- Encoding systems
- Information systems

S2. Evaluation and Testing

- Testing

ALT1. Interactive Information Systems

- Web design
- Databases
- Samples

ALT2. Analytics

- Analytics
- Data collection
- Interpretation of data
- Samples

ALT 3. Modelling and Simulation

- Modelling / simulation
- Samples

ALT4. Embedded Systems

- Computing Inputs and Outputs
- Micro:bit
- Raspberry Pi
- Arduino
- Robotics
- Samples

Programming Technologies

- Python
- JavaScript
- HTML / CSS

Teaching and Learning

- Pedagogy
- Digital Technologies
- SEN

Useful Websites

Appendix A

List of members of the NCCA Computer Science Development Group

Chair	Oliver McGarr
Association of Community & Comprehensive Schools	Paul Behan
Association of Secondary Teachers Ireland	Geraldine O'Brien
Association of Secondary Teachers Ireland	Mark Walshe
Computers in Education Society of Ireland	John Hegarty
Co-opted	Cornelia Connolly
Co-opted	Padraig Cunningham
Co-opted	Kevin Marshall
Department of Education & Skills	Tony Weir
Education & Training Boards Ireland	Stephen Gallagher
Irish Business Employers Confederation	Claire Conneely
Irish Universities Association	Monica Ward
Joint Managerial Body	Alan Kinsella
National Parents Council Post Primary	Geoffrey Browne
Quality & Qualifications Ireland	Joe English
State Examinations Commission	Hugh McManus
Teachers' Union of Ireland	Aengus Byrne
Teachers' Union of Ireland	Ciaran Callaghan

Jake Byrne from TCD was commissioned by the NCCA to lead the specification writing process.

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This resource is available to download from **www.pdst.ie/publications**