

A Review of the Supports Available to Third-Level Programming Students in Ireland.

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Abstract.

Computer Science and programming courses are generally considered to be difficult, particularly for students in the first year of a third-level course. As such, it is an important role to support these students as they begin their education in order to better cement their learning, and to reduce drop-out rates and other early issues. In Ireland, many third-level institutions offer additional dedicated supports to their Computer Science and programming students to augment the traditional lectures, tutorials, and laboratory sessions.

This paper provides a review of the current state of Computer Science Support in Ireland. It features case studies from a sample of six third-level institutions, with authors from each institution detailing the support services they offer to their students. A survey was also sent to all third-level institutions in Ireland, asking for feedback about their support services (or lack thereof). Fifteen responses were received from institutions who provide additional supports (no responses were received from institutions without).

From the results of this survey, and the authors' personal perspectives and experience, recommendations will be made for those looking to develop their own support services,

or to improve upon existing ones. Some of the key findings from this survey are that most supports in Ireland come in the form of dedicated tutors or support centres, more support is offered on average earlier in undergraduate degrees and that most respondents agree that we need to support novice programmers. Some of the recommendations include all institutions offering some form of support service, offering it as a free service and ensuring all ability levels are catered for. Advertising the service appropriately is also important.

It is the correct time to undertake such a review due to the continued growth of Computer Science as a subject, not only at third level, but now also at second level with the introduction of Computer Science to the Leaving Certificate options. Further work is ongoing in this area, with both a national group setup and an annual workshop planned to enter its second iteration in 2022.

Keywords: Computer Science Education; Computer Science supports; Helpdesks; Interventions; Review paper.

1. Introduction.

Computer Science (CS) at third level is difficult with learning to program being cited regularly as a key stumbling block for students (Bennedsen & Caspersen, 2007; Lahtinen et al., 2005; Noone & Mooney, 2018; Rubiano et al., 2015; Watson & Li, 2014). The majority of students entering third level CS courses have no formal experience in the subject, and thus, it is important that we offer additional support to our students when they begin their programming careers. In Ireland, many third-level institutions offer some form of support to their undergraduate students. Some of these supports include “*support centres*”, a specific location where students can drop in to get help with concepts and assignments, help desks, individual and group tutorials with dedicated tutors, among others. These supports tend to be remedial, in general aiming to improve the knowledge of struggling students, while some also offer additional material to students looking to be challenged.

In this paper, the authors aim to summarise and discuss the current state of Computer Science Supports (referred to as CSS herein) in Ireland. We will examine this through case studies from the author institutions and a national summary produced from a survey, with some comparisons drawn to other forms of support. From the results of this review, we will present what works well in CSS. and what does not. We will provide recommendations and guidelines for institutions who are aiming to introduce or augment CSS. Some of these recommendations will also be useful for schools who are supporting students on the new Leaving Certificate Computer Science course.

2. Motivation.

In educational terms, CS is a relatively new subject, with many unknowns in terms of what teaching approaches are suitable. CS only became its own discipline in the 1960s with George Forsythe coining the term “*Computer Science*” in 1961. There are known and established pedagogical approaches to teaching subjects like mathematics, languages, history, or accountancy, but CS educators are still learning about the best approaches to teaching CS. Regardless of the pedagogical approach to teaching the subject, there are some educational principles that apply to CS, as well as other subjects. These are that early success is important (Guskey, 1987) and persistence and resilience are required when learning something that might be challenging. A growth mindset (Dweck, 2017) is key to learning new things and it is important to support learners on their learning journey. Programming is a skill that initially appears different from other skills and that could be off-putting for some students. Therefore, it is important to demonstrate to students that they can program, and that they can succeed, given the right work ethic. This positive approach is one that is very relevant to programming support initiatives. When learners are stretched and moved into their Zone of Proximal Development (Vygotsky, 1966) it is important to help them learn and understand new concepts.

The authors of this paper and the teams that we work with are interested in investigating what type of programming supports are currently offered in Ireland. There is a variety of approaches being used across the different institutions and we want to learn from each other. We want to see what works well and what mistakes should be avoided in this area. It is also helpful to compare what is happening in Ireland to what is happening internationally, to determine if we are in line with elsewhere. Factors such as the student profile, institutional resources available, teaching philosophy, class size, contact hours all must be taken into consideration.

While not exclusively an Irish initiative (many UK institutions offer Peer-Assisted Study Session for example), most Computer Science Supports identified were in an Irish setting, and hence the focus of this paper will be in the Irish context. Computer Science Supports are not a new concept in Ireland – many third level institutions have provided support to students over many years. However, we have reached an interesting juncture in CS education in Ireland. A local branch of the ACM’s SIGCSE, SIGCSEire (Éire is the official name for Ireland) was set up in December 2019. There is now a new CS course being offered at second level for the first time and there is a cohort of researchers and academics who have a particular focus on CS education. These factors have galvanised the CS education community in Ireland and spurred

it on to focus on how to improve supports to CS students. The following sections provide an overview of the CS education context in Ireland.

3. Background.

In Ireland, Computer Science has been solely a third-level subject until the inception of the Leaving Certificate subject in 2018 which was offered as a pilot subject in 40 schools. From 2020 CS has been available for all schools to include in their subject offerings. The curriculum is constructed of three strands with learning outcomes interwoven. These strands are “*Practices and Principles*”, “*Core concepts*” and “*Computer Science in Practice*”. This still means that for the most part, students will have had no formal exposure to CS prior to third level. Historically it has been observed, through high failure and attrition rates and anecdotal evidence, that students have required additional support. These supports may come in many different forms however, for the purposes of this study, we define Computer Science Support as any additional service that is available to students outside of their timetabled hours.

Following a search of the literature using terms such as “*drop-in service*”, “*support centre*”, “*CS1 support*”, it was evident that there is a lack of literature relating to CSS for CS students. Of the literature that was found, there are supports that are offered to students as part of a CS course (Campbell & Craig, 2018). These tend to come in the form of mandatory labs or office hours (hours timetabled for the module leader to be available for students to ask questions). The mandatory labs are often scheduled into the timetable. These often have some form of lab instructor, usually an undergraduate or postgraduate student, however, it is important to note that not all institutions follow this model, and some have lecturer lead labs and tutorials. While these are not explicitly “*support services*” there is an element of this model that is extremely effective. Through having undergraduate/postgraduate students as tutors in the lab, a “*peer*” relationship can quickly be formed given the tutors are closest to their year of study. In addition to the labs, lecturers often offer office hours. While these are of interest to many students, there is a power dynamic to navigate which the student would have to be comfortable in doing so. Smith et al. investigated the use of one-on-one office hours with peer tutors and found that this reduced the likelihood of the “*power*” dynamic however it was found that the situation was not ideal due in part to potential high waiting times and unequal distribution of instruction time among other issues (Smith et al., 2017).

More traditional support services revolve around the model of a “*drop-in*” service. These models

generally are staffed by paid or voluntary tutors, generally by undergraduate or postgraduate students. This is an intentional design choice in an attempt to foster relationships between the students and the tutors and break down barriers to learning. This pedagogical design choice is similar to Peer Assisted Study Sessions (PASS) (Dawson et al., 2014; Geerlings et al., 2016). It should be noted that many of the institutional services that will be described in Section 4 will draw similarities to PASS whereby tutors and students are working cooperatively to share subject-related materials and knowledge. While there have been international supports such as drop-in services and software studios, all designed to support students, given that we are examining an Irish context, the following third-level institutions in Ireland have successful services set up.

- Computer Science Centre at Maynooth University (Nolan et al., 2015, 2020; Noone et al., 2021),
- Computer Drop-In Support Centre (ComputerDISC) at the National University Galway (National University of Ireland Galway, 2021),
- Programming Support HelpDesk at Dublin City University (Dublin City University, 2021),
- Computing Support Service at the National College of Ireland (National College of Ireland, 2021),
- Undergraduate Programming Centre at Trinity College Dublin (Stamouli et al., 2004; Trinity College Dublin, 2021),
- Computer Science Support Centre (CSSC) at University College Dublin (University College Dublin, 2021),
- IT Learning Centre at Dundalk Institute of Technology (Dundalk Institute of Technology, 2021).

Section 4 will outline some of the supports which Irish institutions are currently offering, or plan to offer. Some of these will be drop-in services like above, while others have different support structures. Each of the contributing author case studies provide a context, an initiative, and any outcomes that there might be.

4. Computer Science Supports Case Studies.

4.1 Maynooth University.

Context.

The Department of Computer Science at Maynooth University hosts over 1000 students per academic year among all computing courses. A large majority of these students (600+) are in the first or second year of their degree. Maynooth University's academic structure allows first year students to choose Computer Science as an optional subject within most degree programs. This may be an option within a general degree (such as Science or Arts), or as part of a specialised degree program (such as Computer Science and Software Engineering). From second year, students can choose to switch from a general degree to a specialised one as long as certain requirements are met (grade-based thresholds, taking the correct options in first year and more). As such, our first-year students come from very different backgrounds and have very different reasons for choosing Computer Science as an option. Some plan to keep it for the full four years, others just want to trial the subject. Therefore, supporting first-year and second-year students as they begin their computing careers is a very important initiative for us.

Initiative.

The Computer Science Centre (CSC) at Maynooth University is a drop-in tutoring service which provides free tutoring to students taking first and second year CS modules. This centre has been running since 2012 and aims to augment student learning in lectures and laboratory sessions by giving students more supports. Students can attend tutorials which take a deeper dive into the material they are covering that week. They can also drop into the CSC's physical room to get additional support with the material. Furthermore, students who are looking for more of a challenge can attend the CSC to work on additional material, competitions and more. The centre is managed by three academic staff members (one lecturer and two tutors). On the ground, volunteer undergraduate students are hired to support the students directly. The idea here is that these students are the closest to the material, having only recently completed it themselves, and moreover, they provide a friendly peer for a student to talk to rather than another academic member of staff who they might not feel comfortable opening up to.

Outcomes.

Using the 2019-2020 academic year as an example, 967 visits to the CSC were made by 180

students. 702 of these visits occurred in semester one, with COVID-19 affecting semester two numbers. The majority of these visits were for first year programming modules. During the academic year 2020-2021, our services moved entirely online with support offered via Microsoft Teams. We plan to move back to drop-in support next year. It has been shown that students who make use of the CSC drop-in service (2+ visits per semester) perform statistically better than their peers on first year programming examinations, with a mean of 56.3% versus the class mean of 50.4% (Noone et al., 2021).

Our students tend to speak very highly of the support they receive. One key element that is highlighted is the weekly tutorial run by the CSC academic tutors, which goes back through that week's lecture material, giving the students a further chance to ground their knowledge before the practical session later in the week. The other comment we often receive is that it is nice to talk to someone (a peer) in a calm, friendly environment about the experiences they are having with the modules. A recent redevelopment of the CSC has been discussed in greater detail in a recent paper, where you can see further statistics and details of how the CSC runs (Noone et al., 2021).

4.2 NUI Galway.

Context.

ComputerDISC (Computer Programming Drop-In Support Centre) is a resource for all NUI Galway students that study computer programming. The purpose of ComputerDISC, which opened in November 2010, is to provide support to students with their self-directed learning in computing topics at all years and levels. It is designed to complement the lectures, tutorials, labs, and other supports that are currently available to students. ComputerDISC is staffed by a lab manager and three experienced tutors with a wide range of programming skills, all of whom are funded through the ComputerDISC budget by Teaching Assistant Fellowships. The academic coordinator for the centre overlooks all aspects of its operation. ComputerDISC has now been open for over ten years and has become firmly established as a valuable resource for NUI Galway students studying programming subjects. The ComputerDISC provides tutoring to students from first year right through to postgraduate level. The centre, which has a dedicated room (Fig 1) in the Information Technology building, supports students from a wide variety of different courses.

Figure 1: ComputerDISC Room in the Information Technology Building at NUI Galway.



Initiative.

Funding is provided through the Information Technology Investment Fund (ITIF) by the Higher Education Authority (HEA) of Ireland. The original application for funding was in 2010 and has been renewed on a yearly basis since. The Manager and tutors who contribute to teaching in ComputerDISC are in receipt of teaching fellowships at MSc or PhD level, including a yearly stipend and course fees at the standard university rate. The tutors work 250 hours over two semesters each year. The roles are advertised as they become available and successful candidates take part in an induction day which involves a round table discussion with existing tutors that is led by the lab manager. The general operations of the centre are discussed which include proactive tutoring – ensuring that each student in the room is receiving support; time management – ensuring that the tutors time is shared; communication – tutors will not know everything and should support each other. Another aspect of this training is to ensure that tutors know what they should not do. This includes providing solutions for weekly assignments or providing solutions for past exam papers. The purpose of DISC is to facilitate student learning and should not be seen as a solution providing service. Students requesting technical support (such as Wi-Fi on their laptop not working) should be directed to the appropriate department in the university. Before the Covid pandemic, all usage of the centre was monitored through a login system as the students enter the room. Students register once, providing all their background details and then just log their visit times with subsequent visits.

Outcomes.

A detailed report is developed for the HEA at the end of each academic year which outlines the operation statistics and student retention figures for the year. Some examples of the statistics recorded are shown below in Table 1 and Table 2 below.

Table 1: Operation Statistics for ComputerDISC.

	2018-2019	2019-2020	2020-2021
Number of Days Open	120	107	135
Total Number of Visits	1287	1323	424
Total Number of Hours Open	480	470	594
Total Number of Hours Spent by Visitors	1583:31	1771:31	n/a
Average Visits per Student	4.36	5.40	5.02
Average Visits per Day	11	12.37	3.7
Average Duration of Visits (Hours)	1:14	1.49	n/a

Table 2: Student Visits by Programme.

Course Code	2018-2019	2019-2020	2020-2021
Bachelor of Arts	52	50	15
Computer Science and Information Technology	68	56	21
Engineering	37	22	11
MSc / PhD (CS and Eng)	3	8	1
MSc in CS (Data Analytics)	2	1	3
MSc/HDip in Software Design & Development	40	33	7
MSc in Digital Media	6	2	1
Other	85	45	25

Another valuable outcome of the centre is to provide PhD and MSc teaching scholarships.

4.3 Dublin City University.

Context.

The School of Computing at Dublin City University (DCU) has approximately 800 students studying computing subjects at undergraduate level. There are three BSc. undergraduate programmes: Computer Science, Computing for Business and Data Science. Students from the three cohorts share some modules, particularly in first year. DCU has a strong emphasis in the practical side of computing and students are expected to be competent programmers in practice and not just in theory. There are 7 computing labs available to students both during

their scheduled lab classes and for independent study. Programming is generally taught in a fairly traditional manner with a combination of lectures and practical labs.

Initiative.

The School of Computing at DCU has used a system of undergraduate lab tutors as its main CSS mechanism for many years. This system sees first year Computer Science students supported by second year tutors in their practical programming lab sessions. The ratio is usually 1 tutor to 10 first year students. First year students are assigned to a computer lab (usually with 10 PCs) for a semester and they have a specific tutor who is assigned to help them during the labs. The lab tutors are selected based on their academic ability in programming. They are invited to become a lab tutor and they are expected to attend a training workshop on being a lab tutor. The workshop covers tutoring do's and don'ts, learning theory, communication skills, dealing with difficult situations, active listening and paraphrasing. Lab tutors participate in role playing activities either as a '*student*', a '*tutor*' or an observer and this gives them an opportunity to prepare for their actual tutoring duties. The tutors learn basic guidelines e.g., that they should not touch the keyboard and ask the student questions to guide them to the answer rather than just providing them with the solution. The lab tutors are paid for their tutoring duties and this is funded directly by the School of Computing.

Outcomes.

This system of having a team of undergraduate lab tutors has worked well for many years. Feedback from first year students and lab tutors is positive. It can be difficult for students to ask questions in a class of 150 students and with this programming support system, the students can get to know their lab tutor and feel more comfortable asking questions. The lab tutors keep an eye on their students and are able to monitor the progress (or lack thereof) of the students in their lab bay. It is also beneficial for the tutors themselves as they learn on the job, it enhances their CV and they get paid for doing a relevant job. Some years ago, there was a programming help desk established that was a drop-in centre for all computing students to consult with a specialised, full-time programming tutor, but this role ceased when the funding ended. A new online programming helpdesk was set up in Semester 1, 2020 but it was only lightly used by students. DCU is currently exploring additional possibilities in this area while continuing to run the undergraduate lab tutor support model. While it is difficult to definitively claim that this model works, there is no doubt that more students would struggle with programming if this support structure was not in place.

4.4 TU Dublin, Tallaght Campus.

Context.

TU Dublin, Tallaght Campus (TUD) currently has ~800 students participating in one of 4 streams (Computing with Software Development, Computing with Data Analytics, Computing with IT Management and Computing with a Language) in either full-time or part-time mode. In addition to our traditional BSc degrees, we offer certificate and Higher Diploma modules. For the most part, particularly in Year 1 Semester 1, students across all programmes and degree programmes tend to take a similar version of CS1 (minor differences due to different lecturers delivering). Once the students have completed Year 1, they begin to specialise in their field, all with a particular focus on practical experience. As can be imagined, trying to support all these students, across different streams in both full time and part time has been challenging.

Initiative.

Currently TUD runs a CSS on a Saturday morning usually staffed by a paid post-graduate student with the intention of supporting all students that require any level of support. Given the practical focus that is put on the assignments, this form of support has become unsustainable due to the need for that post-graduate student requiring a working knowledge of all technologies being used across all years. In Semester 1 of 2021, it is planned that a new CSS will be launched in TUD with a particular focus on Year 1 students. The model that will be implemented will be on similar to Maynooth University as described in (Noone et al., 2021). This model was chosen as the pedagogical approach utilised is one of peer-tutoring. In addition, one key feature of MU support service is that there is no lecturer involvement. Having this system ensures that both students and tutors have a relaxed learning environment. Our tutor base would be from the second- and third-year students primarily as they are the closest in both skill level and material. This dynamic should be conducive to student learning and ultimately improving student outcomes.

In terms of a protocol of interaction, the tutors for the service are given a set of guidelines, the actual interaction between the tutor and student is free-flowing and unstructured. In general, there is a loose protocol that a tutor will follow when helping a student with a programming concept. The tutor and student will sit together and use pen and paper. The tutor will work through examples of the concept with the student, gently probing and encouraging the student to interact with them. A session typically concludes when the student can work through an

example of the problem unassisted. To ensure that the service organically grows to support the students, the service will be limited to only first year programming initially. This intentional limitation on the service is to ensure that resources are not over stretched leading to negative experiences.

Outcomes.

With the introduction of the new service, it is hoped that the following outcomes would be achieved:

1. It is hoped that with the new initiative that students who are at risk as identified either by themselves, their lecturer or their tutor would attend and ultimately utilise the service to decrease overall failure rates in first year Computing.
2. Students who would volunteer their time to the service would also experience some level of learning as they have to have a good understanding of the concept to teach it. They would also be able to enhance their CV by stating they are volunteering for the service.
3. The following year of the service should see an increase of modules being supported.

4.5 National College of Ireland.

Context.

The National College of Ireland's CSS was established in the early 2000's. The focus was on 1st and 2nd year UG students. Since then, it has evolved and is available to all full-time and part-time students in the School of Computing. Initially we provided a face-to-face service, now we also provide online and streamed services.

Computing Support is embedded in NCI and is involved in both School of Computing Committee meetings and college Learning, Teaching and Assessment meetings. We are involved in module and programme development. The knowledge from Computing Support is valuable in this process as we know first-hand where students struggle. The staff traditionally lecture also, becoming familiar to new students; designing and delivering content, thus understanding the knowledge gaps experienced by students.

The office for the service is based in the School of Computing itself, where students walk past,

to and from class regularly. We work closely with the other supports such as Learning Support service, Math support and Assistive Technology support.

Initiative.

There are 2 fulltime Computing Support staff (hereafter, we). One works primarily with fulltime students and that role is currently supported by the Higher Education Authority (HEA). The other works primarily with parttime students and is currently funded by Springboard. Other tutors are sourced as required, mainly UG students in their final year or from MSc programmes, utilising peer to peer support. We also look to Associate Faculty members, especially for niche subject areas. All tutors are paid. We have always placed a strong emphasis on good pedagogy, and this is an important factor when choosing tutors.

Emphasis in Computing Support over the years has been around breaking down barriers to students seeking assistance and removing the stigma from support. To this end the fulltime staff look to be in amongst them in labs and classes, lecturing in their 1st semester to help bridge the gap, working to settle students in and get them set up.

The relationship with the class representatives is important in letting students know about our service, also in identifying if supports are needed at an early stage. They are also valuable in helping remove the stigma of the service being only for remedial students. The service regularly gets good feedback from individuals and in the class representative meetings.

The pedagogical focus during supports is on giving students good foundations and encouraging independent learning. This means focusing on problem solving, planning and trouble shooting skills. We also look for correct formatting and commenting to be used when coding. Support teaching is done by modelling all the above. Supports are very interactive, problem solving is done using a ladibug (portable document viewer) or online whiteboard.

Outcomes.

Computing Support deliver a range of services:

- Weekly support classes during all terms in core programming languages at UG & HDip level.
- A series of support classes as requested by the class.
- One-off support classes as requested.
- 1 on 1 tutorials for UG & HDip students, these can be once-off or regular weekly

supports.

- Exam preparation classes.
- Project support classes.
- Short series of summer support classes for repeating students.
- Dedicated Moodle page with resources, recordings and links to online classes with a permanent link on the Moodle dashboard.
- We provide support via email and teams chat if a student doesn't have time.
- PG and MSc programmes are also supported as requested.

All the above have the option of being provided online or face to face (F2F). Supports in core programming languages are delivered both online and F2F. In recent years, at UG level, they are also streamed. When support classes are online only, they are recorded.

Projects that were initiated by or currently run by Computing Support:

- TY Summer Camps (14-16 yrs).
- Discover University Computing Programme (14-17 yrs).
- Coding Clubs (9-12 yrs).
- Post Graduate Boot Camps.

The services are available between 9am – 9pm Mon-Fri and 9-6pm on Saturdays, providing flexibility and ease of access to students working. As it is never an option to replace going to class – supports must be timetabled outside of student class times.

4.6 Dublin Business School.

Context.

In conjunction with Dublin Business School's academic supports, and the growth of computing programmes across the institute, Computing Academic Technical Support (CATS) was designed to provide technology expertise, resources, and services directly to students and faculty. The initial proposal was in response to the growing technical needs of learners, across programmes. For the majority of Computer Science subjects, hands-on learning is becoming the only effective way to get the students to fully understand concepts such as programming, as unlike a lot of

disciplines the more mathematical approach does not always support self-directed or reflective learning. CS is not just about manipulating some program code; it requires constant engagement with new materials and ideas. The ongoing need for programming and problem solving to be practical to be understood was evident based on learner and faculty feedback.

Until recently computing supports within DBS provided assistance to students at an undergraduate level in basic mathematical and IT skills, but there has been a noticeable increase or request for this support on Higher Diplomas and MSc programmes, as well as an identifiable need for programming support at all levels. Programming and mathematical modules have historically demonstrated the highest rate of failure and academic impoverishment across the computing programmes.

Initiative.

CATS was designed to provide support across the computing discipline agnostic of specific programme content, whilst also providing information on the use of technology in teaching and learning environments. The support was implemented through faculty, library and Information & Resource Centre, with the objective for being scalable and responsive to learner needs. The programme is directly funded by DBS itself. Supporting knowledge sharing between PG and UG learners, encouraging the creation of additional supports. The mission of Computing Technical Support is to plan, develop, implement, maintain, and manage, in a cost-effective and scalable manner, those computing technologies and resources necessary to facilitate the teaching-learning process supporting students in the acquisition of knowledge through instructionally related research, scholarly publications, and creative works.

The current support structure is mapped around the delivery of Asynchronous, Group Training, 1-2-1 Training and Further Supports. The college offers Group Training skills workshops advertised through a variety of channels, addressing multiple languages at foundation, intermediate and advanced levels. In the initial pilot scheme 9 of the modules were offered for the latter part of the semester where students were invited to self-register. This resulted in an 85% uptake within 24 hours, particularly around Python classes that were fully subscribed.

These skills workshops are supplemented through 1-2-1 drop-in sessions where students can log a ticket or issue to have specialist support scheduled through the library and course director. Asynchronous materials are developed by faculty and supplemented through online publicly available resources. All these materials and resources are managed to an internal Moodle page where learners can self-register to access all available materials and self-direct their learning

expiring through the CATS support.

Outcomes.

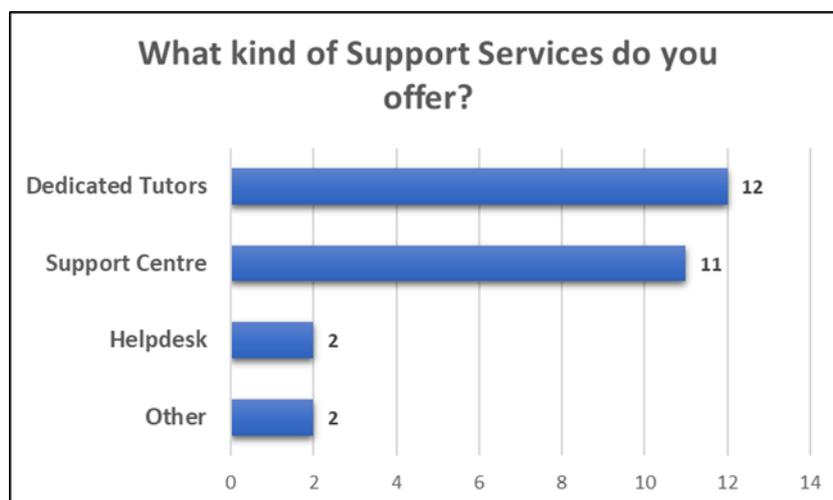
The CATS programme is still in the pilot phase, but current rollout and response has been highly positive, participation to the workshops alone has been at 96% of maximum capacity. The programme has even received commendation in recent QQI programme revalidation from external panels. Going forward the goal is to further establish a catalogue of asynchronous materials and develop responsive skills workshops around identified problem domains from the 1-2-1 drop-in Sessions.

Subsequently the development of further supports including supervised study groups, student peer assistant (PG to Support UG), engagement in computing competitions and strengthening engagement with appropriate in-house societies is also being considered for development.

5. The National Perspective.

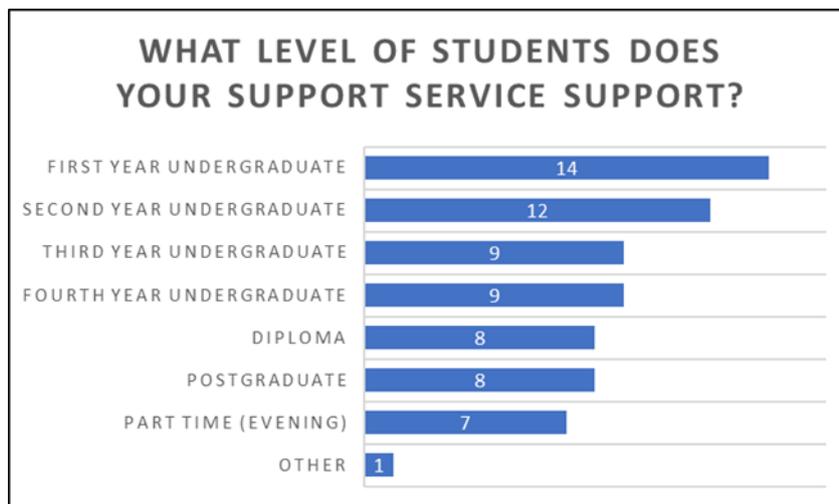
A survey (see Appendix A) was sent to 23 higher education institutions in Ireland that offer CS. Fifteen institutions provided feedback, and it must be noted here that only institutions that do offer a form of support responded, as noted by the branching questions of the survey. Eight responses came from universities, four from institutes of technology, two from colleges and one from a further education centre. In relation to the kind of CSS offered, Figure 2 presents the responses – multiple responses could be ticked. The “Other” response relates to “Device Loans” and “Support Class”.

Figure 2: Overview of the support services offered in each respondent institution.



Respondents then provided insight into the level of student that they support. Figure 3 presents the feedback to this question. The majority of institutions offer support to first and second-year undergraduate students as can be seen in Figure 3.

Figure 3: Overview of the level of students supported.



Respondents were then asked about the average number of attendees they had at their CSS over the last three years. As some CSS are new and others have no recorded data, we cannot provide a detailed overview of this. Of the institutions that provided feedback on this the values provided ranged from 30 to 1200 visits. Several respondents highlighted the pandemic as being an issue around student visits.

There are many models employed for who provides the supports to the students and we wanted to capture the styles employed amongst our respondents. Figure 4 presents the models used with the “Paid Postgraduate” and “Permanent or Contract Tutors” options being the most popular model. Again, it should be noted here that each respondent could select multiple options here.

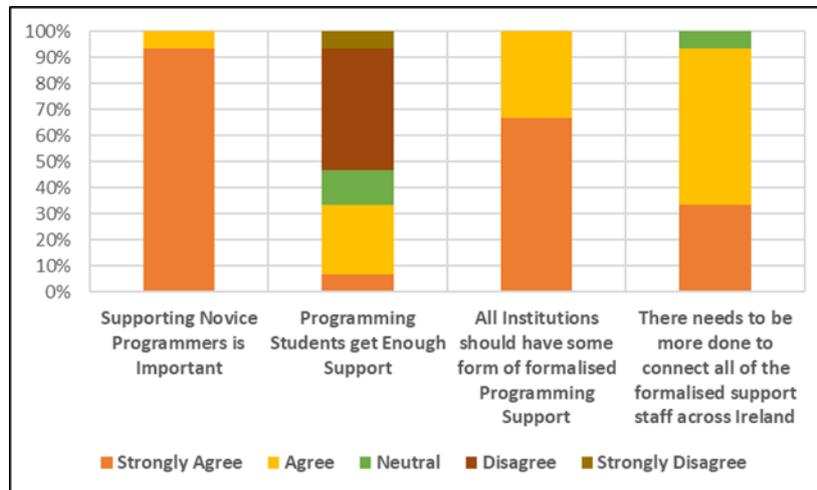
Figure 4: Model of support utilised.

The survey also asked four questions in Likert scale format, with five possible answers: Strongly Agree, Agree, Neutral, Disagree and Strongly Agree. These questions were:

- Supporting Novice Programmers is Important.
- Programming Students get Enough Support.
- All Institutions should have some form of formalised Programming Support.
- There needs to be more done to connect all of the formalised support staff across Ireland.

The responses to these questions are presented in Figure 5. It is encouraging to see that all respondents felt that supporting novice programmers is important. In relation to whether programming students get enough support eight of the fifteen respondents did not feel that this was the case. When asked if they felt that all institutions should have some form of formalised support all respondents felt that this should be the case. Finally, in relation to whether there should be more done to connect all of the formalised support staff in Ireland, fourteen of the fifteen respondents felt that more should be done on this matter.

When analysing the survey, we were interested to see if there were any differences in responses from people in the different types of institutions. No discernible differences were detected across all responses.

Figure 5: Responses to Likert Scale questions.

6. Suggestions and Recommendations.

The purpose of this section is to investigate where the experiences to date of computing support services can be used to assist in allowing already existing services to learn from one another and in the setup of new services across Irish and international institutions. There is limited published work on the provision of computing support within Ireland (and indeed internationally), so this paper aims to collate the experiences of several Irish institutions.

We can see that an earlier paper by Noone, Thompson and Mooney (2021) describing the CSS in Maynooth University has already proved useful in this regard as TUD is using this paper to provide a blueprint to design a new service. For this reason, amongst others, we consider further academic work on the provision of computer support services to be a worthwhile enterprise.

From the case studies in Section 4 we can see that there are a number of models being pursued in the provision of computing support services. Contributing institutions in general appear to be happy with their current models (see Section 4) – however given that the contributors to this paper are a self-selecting group this may not reflect the experience of all Irish institutions.

So far, we can see three basic models for the provision of tutors. The different models chosen may reflect different requirements, student mixes supported and possibly both the financial and physical resources available. Models have evolved over time. The three basic models are:

Peer to peer – undergraduate tutors (MU, TUD, DCU, NCI).

Peer to peer – postgraduate MSC and PHD level tutors (NCI, NUIG).

Dedicated professional tutors (NCI, DBS).

Suggestions for the Design and Operations of Computer Science Supports:

- Advertising the service is important. Particularly for students in their first year of engagement with the institution. Such students are bombarded with a multiplicity of messages and the very students who are at risk of dropping out may be the ones who don't realise support is available.
- Most services are targeted at students at risk of dropping out altogether or of failing modules – however where resources permit if the service is positioned as being available to all ability levels this has multiple benefits (Noone et al., 2021).
- Some long running programmes (MU, NCI) report that running weekly tutorial classes that follow a module one week behind works well.
- The service should be free and clearly advertised as such (international students may not appreciate that such services are offered as free).
- Where institutional resources permit a dedicated space is felt to be highly beneficial.
- The peer-to-peer model has been reported to be very successful by several institutions.
- A strong emphasis on good pedagogy is important when choosing tutors and should also be included in all tutor training.
- CSS that are supporting a mixed profile of students should not expect single individuals to support a wide range of students. Tutors with different skill sets will need to work together to support a mixed student profile.
- Very large programmes such as that of NCI (almost 2000 students in the School of Computing) may benefit from full time professional tutors who are responsible for tutoring themselves as well as organising peer to peer tutoring.
- Programmes with large numbers of mature students (primarily HDips) such as NCI, may benefit from professional tutors as these students are typically in full-time employment and as such are very time poor. They appreciate a targeted intervention from a fellow professional.
- There are very few clear “*don'ts*” – except perhaps that a successful long-term programme should have a clear view of how the programme should be funded over the

long term.

- The ability to provide CSS remotely was especially useful during pandemic lockdowns. Institutions that have not yet performed research on outcomes should consider doing so.
- The reports from participating institutions are universally positive and as such our strongest recommendation is that all institutions provide computing support services. The research that is available supports this conclusion.

7. Ongoing Work.

The primary goals in publishing this paper are to both showcase the current state of Computer Science Supports in Ireland, and to encourage other institutions that do not have structured support to consider utilising it. With that in mind, much further work around this topic is planned.

In March 2021, the first annual “*Role of Computer Science Support Centres*” workshop (National Forum for the Enhancement of Teaching and Learning in Higher Education, 2021) was held online. This event featured presentations from numerous support staff in Irish institutions, as well as an international keynote speaker. This event precluded the formation of this paper, and a further event is planned for 2022. Alongside the continued planning for this event, a national committee will be formed under the title “*Computer Science Support Ireland*”. This committee will be responsible for the annual planning of the workshop, organising further future studies and publication, maintaining shared resources between institutions, among other responsibilities.

Future studies that are in discussion include another perspective study focusing on students, tutors and other academic staff members who are not directly involved in their institutions CSS. It is important to document these viewpoints to help further determine what is working and what is not. We also aim to encourage the creation of more single institution case studies, as the currently published literature in Ireland is very limited given the high frequency of good work that is being done. This will help all institutions to support their students better, and to encourage the spread of structured support to other institutions and countries. In addition, studies are planned surrounding the investigation of concepts which students are struggling with. Anecdotal evidence would suggest that students in CS1 tend to find concepts such as loops and substrings.

Finally, having learned from each other's perspectives, the authors plan to incorporate some elements of each other's CSS into their own centres and helpdesks.

8. Conclusions.

The goal of this work is to bring together the perspectives of the various computer programming support initiatives that can be found in third level institutions throughout Ireland. The questions posed at the outset were to consider what works well and what does not, and to provide recommendations and guidelines regarding Computer Science Supports.

From our six case studies, outlined in Section 4, we can see a large variation in approach amongst the institutions which provides a wealth of knowledge to those considering starting a new support initiative. Though the institutions have largely worked in isolation, there are also many similarities in the initiatives that have proven to work well.

MU was an early adopter of CSS in Ireland, currently providing weekly support tutorials to back up class content, tutoring and receives HEA funding for its initiative. NUI Galway was also an early adopter with their CSS operating for over 10 years. To date, many of the tutors have successfully completed research masters and PhD programmes. DCU also has a well-established CSS, providing tutors during labs. It also provides workshops, however they found that a help desk initiative was not taken up well by students. TU Dublin has recently set up a new CSS that runs on a Saturday only and provides 1-to-1 tutoring. They have clear goals to expand their service. NCI was also an early adopter of CSS, providing a broad range of supports both online and on campus. They are also funded by the HEA. DBS has also recently started its CSS based on student requests. It currently offers support for 9 modules through 1-to-1 tutorials and support classes.

We can see from this review that computing support services remain an expanding and evolving area in institutions. When faced with COVID-19, HE Institutions resorted to emergency online education, giving rise to an increase in the supports that they offered students. It allowed institutions who had previously only delivered their supports on-campus, to have an opportunity to deliver them online and to see the benefits of this mode of delivery such as providing support for a greater number of students when not restricted to physical on-campus workspaces.

The recommendations in this review reflect the findings which have been brought together by the contributing institutions. There are many aspects to be considered with CSS such as

funding; location; staffing; service availability; student cohorts etc. that must be considered based on the circumstances of the institution. To date, these support initiatives have been developed in isolation, but we believe there is a lot to be gained from coming together and learning from each other's perspectives. To this end, the first annual "Role of Computer Science Support Centres" event was organised with further events being planned. This was well attended providing valuable insights. The participants of the event agreed that this initiative should be progressed further, undertaking participation in this review, and creating a knowledge base.

This review shows a need for continued funding in CSS across Ireland, so that institutions can set up and grow their initiatives. This is aligned with the National Forum's Student Success Strategy (O'Farrell, 2019), which looks to enable student success in Irish Higher Education. By having CSS, HE Institutions are providing equitable access to their computing programmes by facilitating students who have no prior background in this area. They are also showing their commitment to their students' success in this continuously growing area.

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Appendix A – CS Supports Survey (Administered via Microsoft Forms)

Supporting Computer Science and Programming students in Ireland

This survey aims to collect information about all support centres, support services and other such supports which target Computer Science students in Ireland. The data provided in this form will be summarised in an upcoming paper examining the state of Computer Science Supports in Ireland. All data is completely anonymous. If you have any questions about the survey, or would be interested in being more involved in this project, or would like to be informed of future workshops or events on the topic of CS support, please contact mark.noone@mu.ie

1. What kind of institution do you represent? *University / Institute of Technology / College / Other*
2. Does your department or institution offer some form of Computer Science or Programming support service? *Yes / No (Branch to Q8) / Other*
3. What kind of support services do you offer? (Select all that apply) *Support Centre / Helpdesk / Dedicated Tutors / Other*
4. What level of students does your support service support? *First Year Undergraduate / Second Year Undergraduate / Third Year Undergraduate / Fourth Year Undergraduate / Diploma / Postgraduate / Part Time (Evening) / Other*
5. What is your three year average for student attendance / usage of your supports? *(Enter your answer)*
6. Does your support service utilise... (Select all that apply) *Lecturer or Administrative Staff Member / Permanent or Contract Tutors / Paid Postgraduates / Volunteer Postgraduates / Paid Undergraduates / Volunteer Undergraduates / Other*
7. What level of support (if any) does your support service get from your institution? (Financially, Understanding of the importance of it's role) *(Enter your answer) (Branch to Q10)*
8. Why do you not currently offer any form of formal support? Would your institution support such an endeavour? *(Enter your answer)*
9. If you don't offer any form of formal support, is there a plan in place to open one in the future? *Yes / No / Other*
10. Please rate the follow statements (**Likert Scale Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree**)
 - Supporting Novice Programmers is Important
 - Programming Students get Enough Support
 - All Institutions should have some form of formalised Programming Support
 - There needs to be more done to connect all of the formalised support staff across Ireland

Note: All "Other" responses record a specific answer.