Application of Bologna Cycle Programme Structures and the European Credit Transfer System to Irish Civil Engineering Programmes

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The objective of this study was to assess, through a cross-institutional comparison, whether higher education institutions in the Republic of Ireland have responded to Bologna Declaration first- and second-cycle program restructuring and applied the European Credit Transfer System (ECTS) to similarly-accredited civil engineering programs in a consistent manner. Assessment strategies were also examined. The predominant programme structure was the pre-Bologna '4+1' structure, demonstrating limited national impact of the principles underpinning the Bologna Declaration cycle concept. The first-cycle programmes differed widely in terms of allocated student workload per ECTS credit as well as in the way that educational outcomes were assessed, which was primarily by written examination. There was no 'best' (or consensus) practice for applying the two-cycle programme structure or ECTS workload norms. This lack of national consensus reveals issues that may have relevance in other countries, 20 years after the signing of the Bologna Declaration.

Keywords: Bologna process; student workload; assessment; programme structure

Introduction

On 19 June 1999, government ministers from Ireland and 28 other European countries signed the Bologna Declaration (European Higher Education Area, 1999). The declaration began what has become known as the Bologna Process to '… [ensure] comparability in the standards and quality of higher-education qualifications' (Alma Mater Studorium, 2019) throughout the European higher education sector [EHEA], thereby enhancing student mobility and international recognition of qualifications awarded by European universities (van der Wende, 2000). Fundamental to enhancing student mobility was adoption of a

uniform measurement system for assessing student workload and learning. The European Credit Transfer System (ECTS), developed in 1989 to encourage student mobility under the ERASMUS programme by *inter alia* 'easing the process of recognising qualifications' (European Commission, 2019), eventually became the *de facto* standard for documenting the 'normal' level of effort required from students to achieve learning outcomes, commensurate with the minimum prescribed scheduled workload and assumed level of prior learning. One year of full-time academic study, which in most European programmes represents student workload ranging from 1,500 to 1,800 hours, is represented by 60 ECTS (European Commission, 2019). Although it is recognised that individual learners will vary in the time required to achieve learning outcomes, it has thus been stated that one ECTS credit corresponds to 25–30 hours of 'normal' student workload (European Commission, 2019). Twenty years after the signing of the Bologna Declaration it is timely to reflect on the implementation of its principles. This study examines the impact of the Declaration on civil engineering education in Ireland from the viewpoints of programme structures and allocated student workload. Furthermore, assessment is considered, recognising that actual workload is influenced by assessment strategy.

More or less concurrently with the Bologna Process, the EU encouraged and funded the development of Thematic Networks (TN) to foster university cooperation programmes on topics of common interest, such as implementing the Bologna process. The European Civil Engineering Education and Training (EUCEET) network (Cammarota and Manoliu, 2001) was one such TN. EUCEET TN evolved into the EUCEET Association (EUCEET Association, 2011a). Among the work programmes of EUCEET was 'Implementation of the two-tier study programmes in civil engineering education across Europe, following the Bologna process' (EUCEET Association, 2011b).

The use of ECTS in engineering programmes at Irish higher education institutions (HEIs) is intimately linked to regulation of the engineering profession. Engineers Ireland (EI) is the professional body that has statutory responsibility, *inter alia,* for 'ensuring that the description "Chartered Engineer" … is confined to a category of engineers who have satisfied the Council [of Engineers Ireland] of their professional competence and experience …' (Office of the Attorney General, 1969). Recently, Irish HEIs were prompted to revise their programmes to comply with a change in EI's requirements regarding the educational standard for a Chartered Engineer (Engineers Ireland, 2015). Currently (2020), persons who have achieved a level of engineering education of EQF Level 7 (European Qualifications Framework for Lifelong Learning) are recognised as meeting the required educational standard in Ireland and may later apply for professional recognition as a chartered engineer. This standard has been in place since 2012.

A grandfather clause for pre-2013 accredited bachelor's degree programme graduates will expire in 2020. Thereafter, holders of a pre-2013 degree will be required to demonstrate evidence of 'further learning' before applying for chartered status. However, graduates post-2012 must achieve one of the following standards:

- an *ab initio* integrated National Framework of Qualification (NFQ) Level 9[1] accredited master's in engineering; or
- an accredited NFQ Level 8 bachelor (honours) degree in engineering plus an accredited NFQ Level 9 master's degree in engineering; or

[1]At a national level, educational programmes in Ireland are classified in the National Framework of Qualifications administered by the government agency Quality and Qualifications Ireland. NFQ Level 8 programmes are honours bachelor's degrees and NFQ Level 9 programmes are master's degrees. See http://www.nfq-qqi.com/ and https://www.qqi.ie/

- an accredited NFQ Level 7 bachelor (ordinary) degree in engineering plus accredited add-on NFQ Level 8 bachelor (honours) and NFQ Level 9 master's degrees.

Thus, students seeking to attain the educational standard for eventual professional recognition as Chartered Engineers in Ireland now can pursue one of three routes: an integrated honours degree programme ending with a master's degree (NFQ Level 9); a two-stage honours programme ending with a master's degree (NFQ Level 8 + NFQ Level 9); or a three-stage programme starting with an ordinary engineering degree (NFQ Level 7) and progressing to an honours bachelor's degree (NFQ Level 8) and master's degree (NFQ Level 9). Ireland's NFQ Level 7 and 8 programmes are referenced to the EQF Level 6 'first cycle', while NFQ Level 9 programmes are referenced to the EQF Level 7 'second cycle', according to the Framework of Qualifications for European Higher Education Area[2].

Prior to entering third level education, students in Ireland complete a minimum of 13 years of classroom studies from age 5. An additional one year can be pursued in a practical "transition year" programme outside the classroom. Entry of most students into third level education is based on achievement in a competitive examination system (the 'leaving certificate' examination). (Other non-competitive routes are available to facilitate students with certain disabilities, those from socially disadvantaged backgrounds and mature students.) The required scores are dictated largely by the availability of student spaces relative to demand, and vary among HEIs, academic disciplines (and sometimes among programmes within disciplines) and from year to year. Prior to the Bologna Process, honours-

[2]The full, approved version is contained in the following report (Report from the Conference of European HE Ministers, Bergen, 2005, Pages 27-28): http://www.ehea.info/media.ehea.info/file/2005_Bergen/37/9/2005_Bergen_BFUG_Report_577379.pdf (Accessed March 2019).

level civil engineering programmes in Ireland were almost exclusively 4-year bachelor's degree programmes, and prior to 2013 graduates from these programmes were eligible to seek professional registration. Following the bachelor's degree, graduates seeking further engineering education could pursue a one- or two-year master's programme (the former being a taught masters and the latter being a research masters) or (exceptional students) could enrol directly in a PhD programme.

EI currently accredits seven active civil engineering programmes at NFQ Level 9 (i.e., second cycle, master's level programmes) and 15 active civil engineering programmes at NFQ Level 8 (i.e., *ab initio* and add-on programmes). However, no comparison has been made of the numerous accredited Irish civil engineering programmes that facilitate learners on the three routes to the educational standard for Chartership. The objective of this study was to assess whether HEIs in the Republic of Ireland had fully embraced the Bologna Process principles of 'first cycle' and 'second cycle' education during the updating of EI-accredited engineering programme structures, and the extent of consistency, if any, in the application of the ECTS to allocated student workload in the updated civil engineering programmes. Assessment strategies also were examined, recognising their impact on actual student workload. The study was part of a larger examination of all European civil engineering programmes being conducted by the EUCEET Association (correspondence to members, 6 June 2018 from I. Manoliu). This study is timely considering that the 20th anniversary of the Bologna Declaration occurred in 2019, a landmark that governments and academia in Europe should use to review evidence of any disconnect between the Bologna principles and the uncoordinated roll-out of those principles across European universities and HEIs.

Methodology

To maximise the relevance of the study internationally, only similar programme groups accredited by EI were examined. Furthermore, because this study was part of a larger pan-EU project, data collection followed a template developed by the EUCEET Association covering course structure, workload distribution and assessment strategy. Content, teaching methods, and other metrics were not included in the EUCEET Association project and were not included in the study reported here. (In-depth comparisons of some Irish and many EU civil engineering programmes are available elsewhere, e.g. EUCEET Association (2011c)). The required data included the names of modules[3] in a programme, and for each module the number of ECTS credits, the assessment method, the semester and year/stage of the module; and the weekly number of lecture hours, seminar hours, project hours, laboratory hours, and individual study (interpreted as self-study) hours. Twenty-two active civil engineering programmes were included in the study, seven of which were graduate programmes and 15 were undergraduate programmes (Table 1).

The required data were extracted from publicly available internet sources (i.e., websites maintained by each HEI offering an accredited civil engineering programme) during June–October 2018. The sources included up-to-date descriptions of the 22 programmes and descriptions for each module (ca. 850). The sources were the same ones that students would use to guide them in their studies, not only in the selection of modules (when choice was possible), but also to understand the normal student workload distribution embodied in each module. Likewise, a prospective student (e.g., an ERASMUS student) would utilize these same sources to assemble a programme of study (e.g., a learning agreement). To assure

[3]Academic terminology varies internationally. In Ireland, 'module' refers to a distinct collection of material on a specific topic or topics and is synonymous with the term 'course' in some countries. Modules are assembled to form a 'programme', which is synonymous with the term 'major' in some countries and with 'course' in other countries.

158 comparability among the Irish datasets, data were extracted from the module descriptors (or
159 from elsewhere in the HEI websites) without interpretation. This approach avoided
160 assumptions about the data supplied by each HEI. Nevertheless, once compiled, each dataset
161 was sent to the appropriate authority in each HEI to review, correct as necessary, and verify.
162 Total student workload per module and its distribution (lectures, tutorials, laboratory,
163 project work and independent self-study) were recorded directly from the published module
164 descriptors. For the analysis reported here, the categories were condensed to total hours,
165 contact hours (through lectures, tutorials, laboratory and seminars, i.e., 'face time'), and
166 independent self-study. Data for each category were accumulated to give a total value across
167 a semester. For reporting purposes this was expressed as an average value per week,
168 assuming 12 teaching weeks per semester. This use of normal student workload as a
169 comparator, though imperfect due to permitted variability in hours-per-ECTS credit (please
170 see the subsequent 'Results and discussion' section), was an appropriate metric given that
171 each HEI subscribed to the Bologna Process, had the same guidance provided by the
172 European Commission for its application, and was accredited by the same engineering
173 professional body. Thus, one would have assumed some consistency among programmes
174 within a given academic discipline (i.e., civil engineering) regarding not only their
175 educational outcomes, but also in the way the that they were structured in terms of normal
176 student workload, etc.
177 Data on mode of assessment in each module were quantified as a percentage allocated
178 between formal written examination and continuous assessment (i.e., non-examination). A
179 simple arithmetic average was determined for student workload per week from the total hours
180 per semester. Contact hours per week were determined assuming a 12-week teaching period
181 per semester. To conform with the EUCEET template (and simplicity in reporting),
182 'equivalent' average independent study hours were determined by averaging over the same

12-week teaching time-frame, although independent study of course would actually occur on a variable basis across the full 15 weeks of the semester. A weighted average was calculated for the annualised assessment metrics, taking account of the ECTS value of each contributing module, which was sometimes higher than a norm of 5 ECTS.

Results and discussion

An analysis was conducted of programme structure; total student workload; workload composition; and student assessment. Trends in the data of the 1st cycle were especially reviewed and reported here.

Structures

The data in Table 1 indicate that the predominant, but not universal, structure of civil engineering curricula in Ireland continues to be the same traditional Anglo-Irish format that was used before the Bologna Process, i.e., four years of undergraduate education (240 ECTS) followed by one year of master's level graduate education (60 ECTS) as a '4+1' programme. Thus, the Bologna principle of differentiating 1st and 2nd cycle education has not been translated into practice. Although Trinity College Dublin (TCD) offers a 5-year integrated programme leading to a master's degree in civil engineering (programme 10, Table 1), it is effectively constructed around a '4+1' offering. Furthermore, the TCD master's programme shares at least 205 ECTS credits (85%) in common with the bachelor's programme in the first 4 years. Commonality of modules rises to 225 (94%) ECTS credits for master's students who do not opt for an internship. Only University College Dublin (UCD) offers integrated civil engineering degrees to master's level in the '3+2' format (programmes 5 + 6; programmes 7 + 8, Table 1), and has done so since the early 2000s (Gibney, 2003).

The most recent pan-European survey of civil engineering programmes was completed in 2009 as an element of EUCEET-III (2006–2009). The survey was sent to all 75

members of the network (Manoliu, 2010) and the responses indicated that although 2 years (120 ECTS) was by far the dominant duration for 2nd cycle programmes, the 1st cycle programmes were approximately evenly split between 3-year and 4-year (180–240 ECTS) programmes. However, among programmes that were then transitioning from an integrated 5-year duration, the '3+2' structure was dominant (Manoliu, 2010, p. 34). The '3+2' structure is now the predominant format for 1st and 2nd cycle programmes across the EHEA, with 180 ECTS characterising the 1st cycle workload of most programmes in more than half of the member countries (European Commission/EACEA/Eurydice, 2018). This indicates a collective connection with the concept of the first three years of university education being 1st cycle and differentiated from 2nd cycle. Less evident however, at least in Ireland, is differentiating the 1st cycle between vocationally based and theoretically based content.

The relative lack of structural difference among most pre- and post-Bologna Irish civil engineering programmes may suggest that many of the programmes have been 'simply' repackaged to conform to the requirements of the ECTS. Previously, in evaluating the effect of the Bologna Process on a variety of EU third level programmes, Alderman (2009) reached such a conclusion. Among the engineering community in Ireland, as in the UK, influential engineers within and outside of academia were vocal in questioning the need to shorten the duration of 1st cycle programmes below 4 years (e.g., Kelly, 2001; McGrath, ca. 2001). Case (2017) documented that diverse and competing interests, not necessarily academic concerns, often shape the structures of engineering programmes. Yet, the preponderance of the '4+1' structure for the 1st and 2nd cycles in Irish civil engineering programmes also may be an unintended result of Irish higher education policy.

Since 1997, Irish students (also other qualifying EU residents, EEA and Swiss nationals) who enrol in recognised full-time undergraduate programmes in Ireland *for the first time* are eligible to have all tuition fees (but not all costs) paid by the Irish Exchequer

(Higher Education Authority, 2003; Department of Education and Science, 2009). The "free fees" initiative was welcomed by families, even though it was not a "free education" initiative. A student 'contribution' (registration fee, amounting to €3,000 per annum in 2019/2020) is not included in the tuition waiver scheme (Higher Education Authority, 2019a), but some students receive government financial assistance that reduces the fee. Importantly, the free tuition scheme supports each year of only the *first* undergraduate degree; subsequent degrees, including graduate (i.e., 2nd cycle) degrees, are *not* included.

Thus, now that a Level 9 (2nd cycle) degree is required to achieve Chartered Engineer status in Ireland (Engineers Ireland, 2015), students enrolled in a '3+2' programme experience twice the personal costs for this degree as those enrolled in '4+1' programmes because the 2nd cycle programme is twice as long. This extra cost has been perceived as a deterrent to students enrolling in '3+2' programmes (and therefore a reason for not developing them). However, the supposition has not been tested and some contrary evidence exists in that UCD's first '3+2' engineering programme (Structural Engineering with Architecture) was over-subscribed from inception until the 2008 economic downturn impacted heavily on construction-related programmes. Despite the lack of evidence that the Irish 'free fees policy' achieved its intended purpose to promote wider access to university education (Organisation for Economic Co-Operation and Development, OECD, 2006), the policy is popular politically and has remained in place despite several years of extremely difficult economic conditions. So, too, has the '4+1' structure in Irish civil engineering programmes.

Total Student Workload

In Europe, the definition of an acceptable time period for third level education has been provided by the Bologna Process, in which '… 60 ECTS credits are allocated to the learning

256 outcomes and associated workload of a full-time academic year or its equivalent' (European
257 Union, 2015). 'Workload' is defined as '… the time [an] individual typically needs to
258 complete all learning activities such as lectures, seminars, projects, practical work, work
259 placements and individual study required to achieve the defined learning outcomes in formal
260 learning environments …'; although workload varies among countries, '… in most cases,
261 workload ranges from 1,500 to 1,800 hours for an academic year, which means that one
262 [ECTS] credit corresponds to 25 to 30 hours of work' (European Union, 2015). The figure is
263 lower in the United Kingdom (UK), with 120 UK credits per annum being the norm, where
264 10 notional hours of learning equate to each UK credit (Quality Assurance Agency, 2018);
265 thus 1 ECTS = 2 UK credits (Universities UK, 2012). Because they were 'Bologna-
266 compliant', the programmes examined in this study were expected to encompass a total
267 student workload of 1,500–1,800 hours per annum according to most European country
268 norms or 1,200 hours per annum according to UK norms.

269 The programmes in this study mostly utilized 15-week semesters comprising 12
270 'teaching weeks', 1 week for 'reading/study' and 1–2 weeks for formal examinations in each
271 semester (Table 1) and all programmes were comprised of 60 ECTS per academic year. One
272 HEI (TCD, programmes 9 and 10, Table 1) utilized 11 teaching weeks and 2 weeks for
273 reading/study per semester. Two HEIs (CIT and WIT, programmes 1315, 21 and 22) utilized
274 13 teaching weeks and 1 week for reading/study per semester. One programme was not
275 offered on a semester basis (IT Carlow, programme 19, Table 1) and hours for it were
276 calculated as the average per week in each 30-week annual stage. Thus, all programmes in
277 this study consisted of 30 weeks per academic year in which students were required to
278 complete the required workload embodied in the modules.

279 Figure 1 illustrates the variation in total hours per week for student workload during
280 the initial and final year of study in each of the programmes listed in Table 1. No universal

relationship existed between the relative workloads in these two years; in other words, the workload in final year was neither universally higher nor lower than that in first year. The same could be said for relative workload in intermediate years (data not shown).

Perhaps the lack of inter-year differences is unremarkable given the fundamental basis of the ECTS. Other than the assumption that one academic year's workload is expected to vary between 1,500 and 1,800 hours (i.e., ± 10% around a mean of 1,650 hours) under the ECTS (European Union, 2015), there is no suggestion within the ECTS framework that more work should be scheduled in the final year of the programme than in the initial year (or, for that matter, between 1st cycle and 2nd cycle programmes). Anecdotally, from conversations with students over a combined half-century of university teaching, the authors question the validity of the assumption that typical learners in final year require no more hours of combined contact and independent study than those taking first year modules. That a greater level of effort may be required as a learner progresses though a programme *is* acknowledged within the ECTS framework, but this difference is not reflected in ECTS credits; instead HEIs are encouraged to utilise 'progression rules' in combination with ECTS (European Union, 2015, p. 21). Figure 1 shows that the Irish civil engineering programmes adhere to the premise that all years require approximately the same amount of combined total hours of workload.

However, fairly large differences are apparent in the average student workload *among* Irish civil engineering programmes. Figure 2 shows the total student workload per week. The global mean is 52 hr wk^{-1} (i.e., average workload of all programmes across all years). The least total average workload (CIT, 42.3 hrs wk^{-1}) is approximately 18.5% less than the global mean and almost 38% less than the greatest total average workload (WIT-1, 67.9 hrs wk^{-1}). However the scheduled contact hours are 10% higher in the CIT programme (22.1 hrs wk^{-1}) than in the WIT-1 programme (19.9 hrs wk^{-1}), demonstrating significant inconsistencies in

306 the hours allocated to independent study per ECTS (0.67 hrs/ECTS in CIT, 1.59 hrs/ECTS in
307 WIT-1). These values differ by a factor of 2.4 but may be apparent rather than real, given that
308 actual independent study hours are not monitored and vary from student to student in
309 accordance with their individual learning needs. Notably, the highest total average annual
310 workload (WIT-1; 1,622 hrs yr^{-1}) fits into the 1,500–1,800 hours of time commitment
311 anticipated in the ECTS framework (European Union, 2015), whereas the mean annual
312 workload of all Irish civil engineering programmes (1,248 hours) is close to the UK norm
313 (Quality Assurance Agency, 2018).

314 As recognized in the Bologna Process, reciprocal recognition of student learning is
315 fundamental to facilitating student movement among HEIs. Within the EHEA, the ECTS is
316 accepted as the tool by which to document student learning. However, for the tool to be truly
317 effective, it must be implemented consistently within all HEIs. As part of the Bologna
318 Process, the EU has provided guidance (e.g., European Union, 2015) for implementing the
319 ECTS uniformly among HEIs, and in Ireland this guidance has been 'translated' into
320 guidance for Irish HEIs (National Qualifications Authority of Ireland, 2006). Similarly, Irish
321 HEIs have guided their academic staff in applying ECTS to modules (e.g., Trinity College
322 Dublin, 2006). Thus, individual academic staff members with responsibility for delivering
323 modules have been the ones to decide how much time and effort (i.e., workload) they think
324 the *typical* student will have to expend to achieve the designated learning outcomes. Even
325 with the benefit of guidance (and subsequent oversight from academic administrators), it
326 seems logical that variations in the application of ECTS could occur. Indeed, it is unknown
327 whether these academics subscribed to the fundamental assumption on which ECTS is based
328 that a typical student should expend 1,650 hours per academic year to master one year of
329 academic work.

330 ***Workload Composition***

331 The average contact hours (or 'face time') with students over the duration of each programme
332 was 15.1–24.8 hrs wk^{-1} (data not shown). The global mean of contact hours for all
333 programmes was 21.5 hrs wk^{-1}, which was about 41% of the global average total student
334 workload (52 hr wk^{-1}). Thus, (by difference) the global average amount of autonomous study
335 time would be expected to be 30.5 hr wk^{-1}, comprising approximately 59% of total time. In
336 comparison, Harmon and Erskine (2017) published results of a national survey (in which
337 respondents were self-selected and data were self-reported) that showed full-time Irish
338 university students generally expected to spend at total of 37.5 hr wk^{-1} on their studies, while
339 students enrolled in science, mathematics, computing and engineering programmes expected
340 to spend slightly more (39.8 hr wk^{-1}). Regarding first-year students transitioning to a
341 university learning environment, Gibney et al. (2011) found that first-year students expected
342 to spend approximately 24 hr wk^{-1} in total attending classes *and* completing academic work.
343 Both of these studies highlight a significant gap between the average workload that civil
344 engineering programme co-ordinators in Ireland, guided by ECTS norms, prescribe their
345 students to undertake, and what students themselves expect to undertake. Indeed, the ECTS
346 approach is understandably a 'one-size-fits-all' approach that assumes the workload of a
347 *typical* student. The actual gap between expectations of students and academic staff members
348 may be much larger than is reflected by self-reported data; in a study of mathematical
349 sciences students from all four university years at one Irish HEI, Kelly (2012) found that
350 measured attendance was less than student-reported lecture attendance. These data
351 corroborate findings by others that university students spend considerably less time studying
352 than is prescribed through module descriptors (Kolari et al., 2006).
353 In contrast to the relative lack of inter-year variation in total workload (Figure 2),
354 there were fewer contact hours in the final year of all programmes than in the first year of
355 each programme (Figure 3). In some programmes, these differences were relatively small

(1.5 hrs wk^{-1}, UCD-2 and UCD-3) but in other programmes were as much as 14.5 hrs wk^{-1} (IT-Carlow). Relative to the number of Year 1 contact hours, the final year contact hours in specific programmes were 6–56% fewer.

The relatively higher number of contact hours in the initial year of programmes may help students transition from secondary level education in which almost all learning takes place within a formal classroom setting. Furthermore, the relatively fewer average number of contact hours in final year may reflect the inclusion of a greater number of project-based assignments and independent research studies that are completed outside of the classroom. Another explanation for the reduced contact hours is that the final year of programmes can be based on the assumption that, relative to their first year counterparts, the more mature final year students can be expected to take more responsibility for their own learning and achieve the learning outcomes envisaged through full use of the hours scheduled as independent study. Indeed, Kelly (2012) found that student attendance was highest in final year modules and suspected that the better attendance was at least in part because these modules were more directly related to a student's particular area of study.

Interestingly, the data for the number of lecture hours (Figure 4) in the first and final years of programmes contradict the conclusions suggested by the differences in contact hours (Figure 3). While some programmes (e.g., UL) devote obviously fewer lecture hours in the final year than in the first year, the converse is also true (DIT-1). It was beyond the scope of this study to examine how content was being taught in the various programmes other than through prescribed workload distribution across contact and independent study hours. Nevertheless, all programmes included some form of final year comprehensive project that was largely (if not entirely) self-directed by students outside of the classroom. Thus, it was somewhat surprising that several programmes included significantly more lecture hours in final year than in first year. In the nationwide survey of Irish university students reported by

Harmon and Erskine (2017), the self-selected respondents that were 4th year students reported that they spent more time on their studies (42.6 hrs wk^{-1}) than did the 1st year students (35.7 hrs wk^{-1}); however, within these total time commitments, the proportion of total study time reportedly devoted to self-study was approximately the same (57.7% and 56%, respectively). Across the EU, students self-report that on average they devote 34 hrs wk^{-1} on academic activities and this time is evenly split between self-study and in-class activity (lectures, laboratories, seminars, etc.) (Hauschildt et al., 2018).

Student assessment

As shown in Figure 5, on average across all years of the civil engineering programmes, most (55%) of a student's final grade was determined by written examination rather than continuous assessment. However, in some programmes (e.g., UCC, DIT-2, IT-Carlow) the reliance on written examinations for assessment was even greater (≈ 60–70%). The study did not evaluate the teaching techniques used in each programme, but the data in Figure 5 suggest that relatively less emphasis is placed on assessing student performance by means other than end-of-semester written examinations (e.g., continuous assessment, project performance, etc.).

The variations in assessment techniques across years (Figure 6) amplify the differences among programmes but exhibit no consistent trends. Given the importance of project work (individual and group design and research projects, etc.) and independent study in final year, a logical assumption would be that continuous assessment would play a greater role in final year than in the initial year of programmes, but such an assumption is not justified by the data portrayed in Figure 6.

These results are similar to those in a recent study of assessment strategies in use across the Irish higher education system (National Forum, 2016). In that study, investigators

concluded that written examinations were ‘the most common assessment method, although [their] popularity and weighting differ[ed] between fields, programmes and stages of programme.’ The same study evaluated the assessment strategies used in a random selection of modules in ‘engineering, manufacturing and construction’ and determined that the ‘relative weighting of examinations changed across programme stages from 44% in first year to 53% in mid-programme to 43% in final year.’

Implications

The comparisons made in this study were based on fundamental concepts embodied in the Bologna Process, i.e., workload and ECTS. In the context of student mobility, descriptions of modules (and the programmes they comprise) in terms of ECTS are vitally important because together with module content, the ECTS affect a prospective international student’s choices of what modules to include in a learning agreement. Arguably, the descriptions of programmes in terms of ECTS and workload could also affect a student’s choice of HEI.

Whether ECTS have been assigned uniformly among Irish HEIs offering accredited civil engineering programmes is still open to question; however, the study results show that inconsistencies exist. For example, there were considerable differences in the reported student workload among several programmes even though all met the same accreditation criteria of Ireland’s professional engineering body (and therefore the Washington Accord). Although the outcomes-based accreditation criteria are non-prescriptive in terms of programme content, a reasonable assumption would be that all accredited programmes within a given discipline should be similar.

Whether the differences in workloads are authentic is unclear because the actual number of hours expended by each student in achieving learning outcomes is a variable, irrespective of norms published in module descriptors. Nevertheless, one would have expected less variation in the average hours across the programmes reported given that their structures were built around 60 ECTS per full-time academic year and the relationship that has been established within the EU regarding annual workload. During the development of the ECTS, consensus within the EHEA was reached both on the average number of hours that EU students spent in HEIs to obtain a degree and on the average number of ECTS credits an academic year should contain; then the value of each ECTS credit was determined by simple division of the two. As deduced by Tsigelny (2011), the ECTS workload assumptions correspond to 5 hours of combined contact and self-study time per day for 5–6 days per week. However, Tsigelny (2011) also quoted a study that theorised that one ECTS credit equated to 28 hours of student workload per week based on the assumption that a typical EU academic year consisted of 42, 5-day weeks.

On the basis of a 42-week academic year, 1,680 hours of combined contact and self-study time for 60 ECTS would require a time commitment of 8 hours day^{-1} (i.e., 8 hours day^{-1} × 5 days $week^{-1}$ × 42 weeks $year^{-1}$ = 1,680 hours $year^{-1}$). The assumed average workload in the ECTS framework is 1,650 hours $year^{-1}$ (European Union, 2015). Notably, the academic year of programmes in this study was comprised of 30 weeks. Consequently, to achieve the ECTS average workload of 1,650 hours per academic year, students would need to devote 11 hours day^{-1} to classroom and self-study activity (i.e., 11 hours day^{-1} × 5 days $week^{-1}$ × 30 weeks $year^{-1}$ = 1,650 hours $year^{-1}$). Anecdotally, this level of time commitment seems unrealistically high.

As acknowledged by the European Union (2015, p. 18), 'The use of ECTS in HEIs requires both an institutional credit framework based on institutional regulations and *a profound understanding of the system by each member of the academic staff*' (emphasis added). It is unknown how individual academic staff members decided to allocate a notional value for total student workload among various categories of learning activities (lectures, etc.). The level of care devoted to writing module descriptors (which were the primary source of data for this study) by academic staff is also unknown. What is clear is that, as described by the documentation endorsed by each HEI, the amount of work embodied in ECTS is significantly higher than that which students themselves intend to expend in meeting the learning outcomes for the programmes reviewed in this study. Indeed, the mean workload of 52 hr wk^{-1} for the civil engineering programmes compared in this study seems unrealistic in comparison to the average workload (39.3 hr wk^{-1}) of full time workers in Ireland (Eurostat, 2019) and the amount of time (34 hrs wk^{-1}) students across the EU report that they expend (Hauschildt et al., 2018).

As noted in the Methodology section, a working assumption during the study was that there would be significant similarities among programmes because they were in a single academic discipline. Differences in ECTS/student workload are recognised among programmes (European Union, 2015), but several of the differences identified in this study seem extraordinary. The differences are somewhat worrying given that all programmes reviewed were accredited by EI under the same general criteria. EI is a signatory to the Washington, Dublin and Sydney Accords and applies "outcomes based" accreditation criteria that are recognised internationally and lead to the reciprocal recognition of qualifications awarded to students who successfully complete the programmes. The EI accreditation criteria also reflect the '… accreditation

processes undertaken by the European Network of Accreditation for Engineering Education, which licenses Engineers Ireland to award the EUR ACE label' (Engineers Ireland, 2014). While outcomes-based accreditation criteria are not prescriptive, the large (apparent) differences in student workload among programmes in this study suggest that programmes having low workload demands enjoy the same accreditation recognition benefits as programmes having high workload demands.

Conclusions

This study demonstrated that the ECTS system established as part of the Bologna Process is fully implemented in all accredited civil engineering programmes in Ireland; however, inconsistences in the application of ECTS among programmes are apparent. A possible reason for the differences is that individual academic staff members may interpret and apply EU guidance about ECTS differently.

No single structure in terms of the durations of 1st and 2nd cycles exists in these programmes. Some examples of the popular European '3+2' structure exist, but the so-called '4+1' structure that was in use prior to the Bologna Process still dominates. This suggests that most 'pre-Bologna' Irish civil engineering programmes have been repackaged to conform to the ECTS system but have not been reformed structurally.

All but one institution has adopted the UK workload norm of 20–25 hrs per ECTS credit, rather than 25–30 hrs norm embodied in the ECTS framework. Even so, the mean specified student workload arising from ECTS allocation for the civil engineering programmes compared in this study seems unrealistically high in comparison to the average workload of full-time workers in Ireland. Indeed, there is lack of clarity in the ECTS

framework about the basis for assuming that 25–30 hrs of student work are required per ECTS credit. This lack of clarity may be a reason for the apparent inconsistent application of the ECTS in the programmes examined in this study.

While there is relatively little variation in student workload from year to year within programmes, there is substantial variation in workload among institutions, despite the fact that all programmes are accredited under the same international scheme (i.e., Washington Accord). Programmes that have a relatively low student workload requirement enjoy the same accreditation privileges as those that have a relatively higher workload requirement. In contrast to total workload, significant differences exist in the number of student contact hours in the first and final years of programmes. This difference might be attributable to the greater proportion of project-based assignments in the final year of study. Written end-of-semester examination dominates other forms of assessment as the assessment technique used to determine student performance in all programmes.

Variations in the balance between written examinations and other assessment exist across years in many programmes but do not exhibit consistent trends. Nevertheless, the reliance on written examinations as assessment of student learning in these programmes is higher than that used in other Irish engineering, manufacturing and construction programmes.

In summary, the application of the ECTS system to accredited Irish civil engineering programmes appears to be inconsistent and may mislead students and academic staff who try to use ECTS as the basis for mobility decisions (learning agreements, etc.) and other study choices (selection of modules, etc.). The accreditation of programmes with widely different workload requirements warrants closer examination.

Acknowledgements

This paper is dedicated to the memory of the late Prof. Iacint Manoliu, Technical University of Civil Engineering Bucharest, who was a key proponent of the original EUCEET TN proposal to the European Union and served as the Chairperson of the EUCEET Management Committee (through all four iterations) and as the Secretary General of the subsequent EUCEET Association from its founding in 2007 until his untimely death in 2018. The authors express their deep appreciation to the numerous academic staff in Irish universities who supplied/reviewed/verified data about their programmes, and to Assoc. Prof. Amanda Gibney for helpful comments on an early draft of this paper. The authors also appreciate the thoughtful and helpful comments made by anonymous reviewers during the peer review process.

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664 Table 1. Irish civil engineering programmes

	Institution (common name)	Abbreviation	Semester Schedule (2 per academic year, 15 weeks each)	Programme	Level	Duration, years
1	National University of Ireland - Galway	NUIG	12 weeks teaching 1–2 weeks reading/revision 1–2 weeks examinations	BE (Hons)[a], Civil Engineering	8	4
2				ME[b], Civil Engineering	9	1
3	University College Cork	UCC	12 weeks teaching 1–2 weeks reading/revision 1–2 weeks examinations	BE (Hons), Civil and Environmental Eng.	8	4
4	University College Dublin	UCD	12 weeks teaching 1–2 weeks reading/revision 1–2 weeks examinations	BE (Hons), Civil Engineering	8	4
5				BSc, Engineering Science[c]	8	3
6				ME, Civil, Structural and Environmental Eng.	9	2
7				BSc, Structural Engineering with Architecture	8	3
8				ME, Structural Engineering with Architecture	9	2
9	Trinity College Dublin	TCD	11 weeks teaching 2 weeks reading/revision	BAI[d], Civil, Structural and Environmental Eng.	8	4

10			2 weeks examinations	MAI[e] Civil, Structural and Environmental Eng.	9	5
11	University of Limerick	UL	12 weeks teaching 1–2 weeks reading/revision 1–2 weeks examinations	BE (Hons), Civil Engineering	8	4
12	Athlone Institute of Technology	AIT	12 weeks teaching 1–2 weeks reading/revision 1–2 weeks examinations	BEng (Hons) Civil Engineering	8	5
13	Cork Institute of Technology	CIT	13 weeks teaching 0–1 weeks reading/revision 1–2 weeks examinations	BEng (Hons), Structural Engineering	8	4
14				MEng, Civil Eng. (Environment and Energy)	9	1
15				MEng, Structural Engineering	9	1
16	Dublin Institute of Technology[f]	DIT	12 weeks teaching 1–2 weeks reading/revision 1–2 weeks examinations	BE (Hons), Civil Engineering	8	4
17				BE (Hons), Structural Engineering	8	4
18				ME, Sustainable Engineering	9	1
19	Institute of Technology, Carlow	IT-Carlow	Not semesterized; 30 weeks of instruction per academic year	BEng (Hons), Civil Engineering	8	4
20	Institute of Technology - Sligo	IT-Sligo	12 weeks teaching 1–2 weeks reading/revision 1–2 weeks examinations	BEng (Hons), Civil Engineering	8	4

21	Waterford Institute of Technology	WIT	13 weeks teaching 1 week reading 1–2 weeks examinations	BEng (Hons), Sustainable Civil Engineering, 3 years Level 7 + 2 years Level 8 ‘add on’	8	3+2
22				BEng (Hons) Sustainable Civil Engineering Level 8 *ab initio*	8	4

[a]Bachelor (Honours level) of Engineering; [b]Master of Engineering; [c]Bachelor of Science in Engineering Science; [d]Bachelor in the Art of Engineering; [e]Master in the Art of Engineering; [f]DIT became a constituent of Technological University Dublin as of 1 January 2019.

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668 Figure 1

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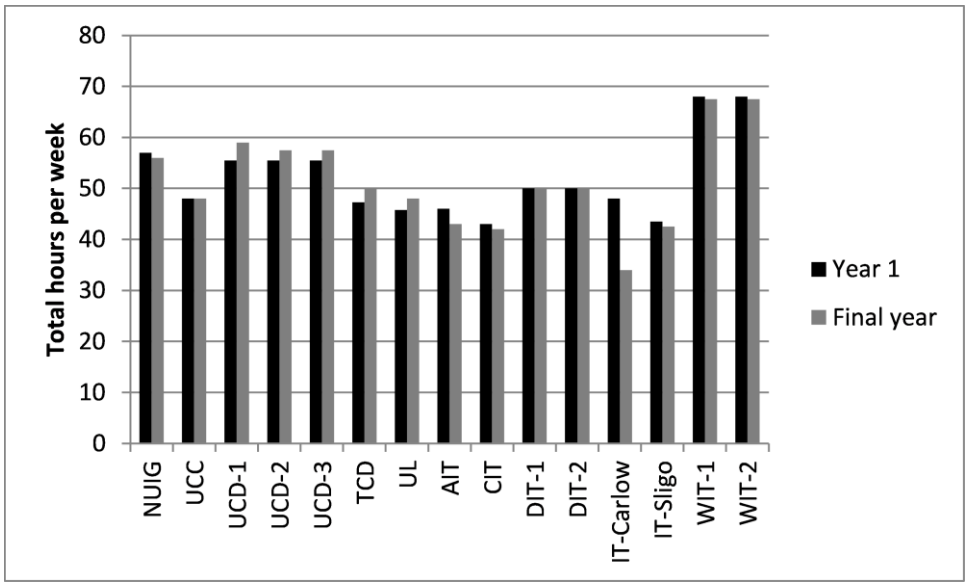

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672 Figure 2

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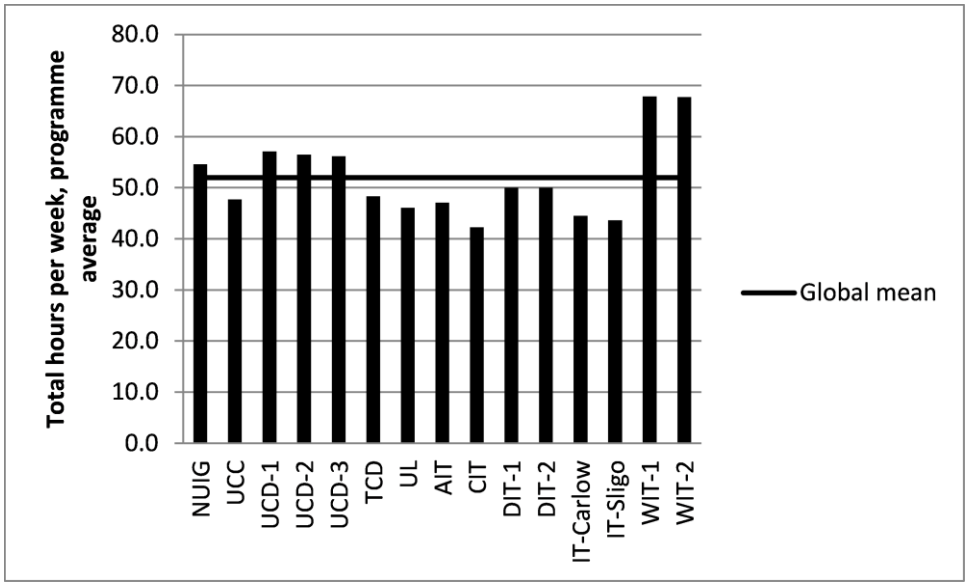

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677 Figure 3

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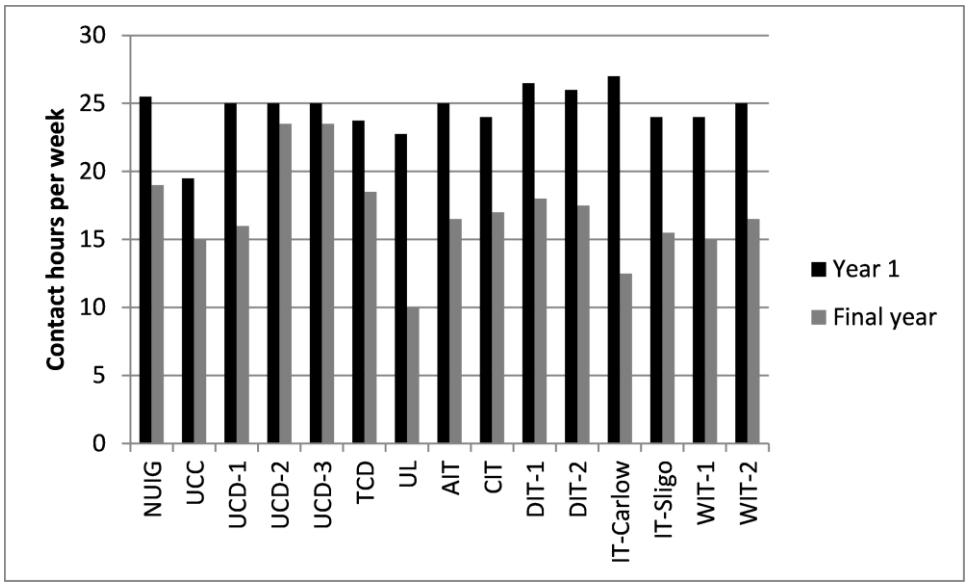

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681 Figure 4

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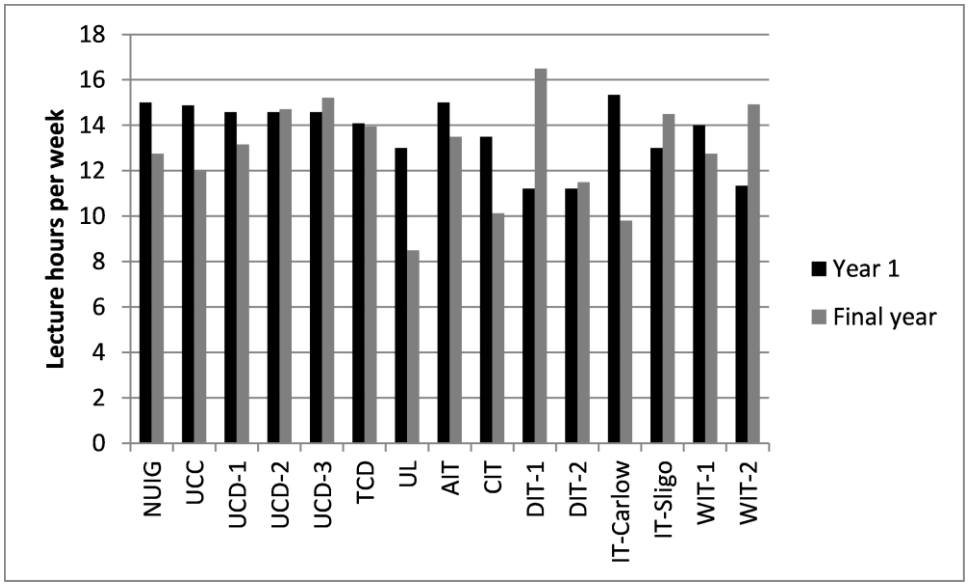

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686 Figure 5

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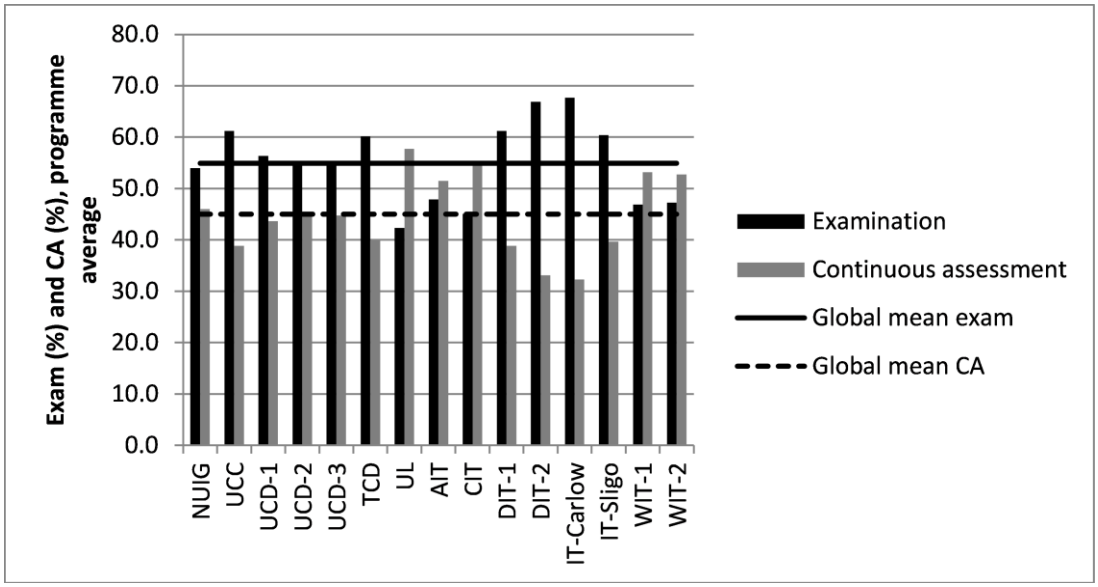

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691 Figure 6

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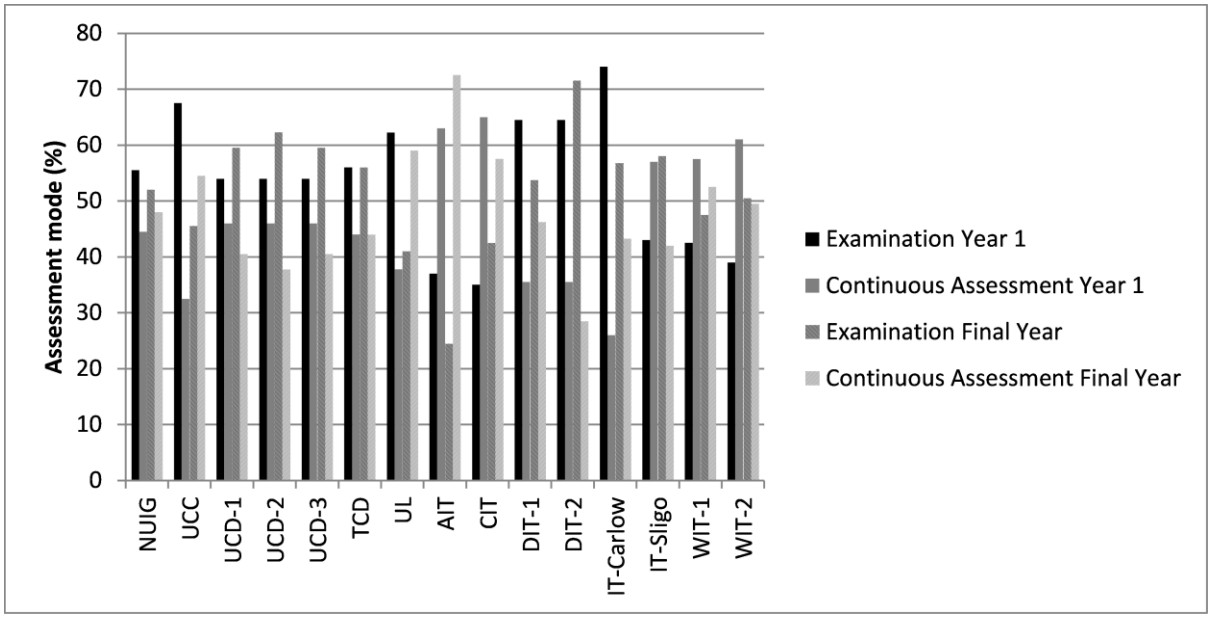

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Figure 1. Comparison of student workload (total hours per week) in the initial and final years of all Level 8 accredited Irish civil engineering programmes. Data are averages for modules comprising each of the two years. Students graduate with a '1st cycle' engineering degree at the end of four years *except* UCD-2 (BSc in Engineering Science, 3 yrs), UCD-3 (BSc Structural Engineering with Architecture, 3 yrs), AIT (BEng in 5 yrs, i.e., 3 yrs Level 7 and 2 yrs Level 8), WIT-1 (BEng in 5 yrs, i.e., 3 yrs Level 7 and 2 yrs Level 8).

Figure 2. Total student workload (hours per week) in all Level 8 accredited Irish civil engineering programmes. Data are averages for the entire duration of each programme (3–5 years). The global mean is the average for all programmes. Students graduate with a '1st cycle' engineering degree at the end of four years *except* UCD-2 (BSc in Engineering Science, 3 yrs), UCD-3 (BSc Structural Engineering with Architecture, 3 yrs), AIT (BEng in 5 yrs, i.e., 3 yrs Level 7 and 2 yrs Level 8), WIT-1 (BEng in 5 yrs, i.e., 3 yrs Level 7 and 2 yrs Level 8).

Figure 3. Comparison of student engagement (contact hours per week) in the initial and final years of all Level 8 accredited Irish civil engineering programmes. Data are averages for modules comprising each of the two years. Students graduate with a '1st cycle' engineering degree at the end of four years *except* UCD-2 (BSc in Engineering Science, 3 yrs), UCD-3 (BSc Structural Engineering with Architecture, 3 yrs), AIT (BEng in 5 yrs, i.e., 3 yrs Level 7 and 2 yrs Level 8), WIT-1 (BEng in 5 yrs, i.e., 3 yrs Level 7 and 2 yrs Level 8).

Figure 4. Comparison of student engagement (lecture hours per week) in the initial and final years of all Level 8 accredited Irish civil engineering programmes. Data are averages for modules comprising each of the two years. Students graduate with a '1st cycle' engineering degree at the end of four years *except* UCD-2 (BSc in Engineering Science, 3 yrs), UCD-3 (BSc Structural Engineering with Architecture, 3 yrs), AIT (BEng in 5 yrs, i.e., 3 yrs Level 7 and 2 yrs Level 8), WIT-1 (BEng in 5 yrs, i.e., 3 yrs Level 7 and 2 yrs Level 8).

Figure 5. Percentages of total programme marks awarded through written examination (Exam) and continuous assessment (CA) in all Level 8 accredited Irish civil engineering programmes. Data are averages for the entire duration of each programme (3–5 years). Global means are averages for all programmes. Students graduate with a '1st cycle' engineering degree at the end of four years *except* UCD-2 (BSc in Engineering Science, 3

726 yrs), UCD-3 (BSc Structural Engineering with Architecture, 3 yrs), AIT (BEng in 5 yrs, i.e.,
727 3 yrs Level 7 and 2 yrs Level 8), WIT-1 (BEng in 5 yrs, i.e., 3 yrs Level 7 and 2 yrs Level 8).

728 **Figure 6.** Comparison of student assessment mode (by examination and continuous
729 assessment) in the initial and final years of all Level 8 accredited Irish civil engineering
730 programmes. Data are averages for each of the two years. Students graduate with a '1st cycle'
731 engineering degree at the end of four years *except* UCD-2 (BSc in Engineering Science, 3
732 yrs), UCD-3 (BSc Structural Engineering with Architecture, 3 yrs), AIT (BEng in 5 yrs, i.e.,
733 3 yrs Level 7 and 2 yrs Level 8), WIT-1 (BEng in 5 yrs, i.e., 3 yrs Level 7 and 2 yrs Level 8).