A Simplified Approach in Teaching Construction Cash Flow Forecasting – Embedding Basic Cash Flow Techniques using a Spreadsheet to Chart a Projects S Curve

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Abstract

A review of the Masters of Construction Management (MCM)program at University of Melbourne (UoM) focused the teaching staff in this area of teaching of Construction Cash Flows. In a new subject offering called ABPL90413 Construction Cost Planning, a dedicated module on cash flow techniques was proposed. This was to be a simplified approach in teaching Construction Cash Flow Forecasting by embedding basic cash flow techniques using spreadsheets and charting. The method proposed for teaching cash flow is linked to the generation of a basic cost plan for a simple residential project and producing a cash flow S-curve. Building on students access to and familiarity with Office 365 spreadsheet tools such as Excel, the module was designed as a step-by-step approach to taking elemental level cost data that students had generated in a cost plan into a time series cash flow statement. On delivery of the new cash flow teaching module in first semester of 2020, a Qualtrics survey instrument was used to gain feedback on student learning experiences and garner sentiment towards the delivery of the module the results of which are presented here.

Keywords
Cash-flow, S curve, Construction Educators, Spreadsheets**,**

1 Introduction

It is a common mantra in the construction industry that "cash is king". Educators in Construction have stressed the need to make the understanding of cash flows a central theme early in a student's education. Construction Cash Flow Forecasting techniques have an important relationship to the over-arching development of industry relevant financial literacy in graduates. The ability to teach construction economics and management students how to develop a basic statement of a project cash flows competes in construction studies with newer developments in curriculum such as 5D costing utilizing BIM based financial models and the cash discounting or 'time value of money' approaches to life cycle analysis.

This approach contrasts with early developments of several decades ago, of more specialized Quantity Surveying/Construction Economics degrees that commonly had an Accounting or Finance subject, teaching students cash flow analysis as a fundamental and generic skill within any business entity. It is now rare to find a bespoke Finance or Accounting subject in Construction Management (CM) programs these days as core teaching.

An internet-based desktop survey of Australian University Construction programs with course(subject) descriptions revealed that whilst cash flow teaching does not warrant a whole individual subject area or complete course of study it is found in such courses or subjects as;

- Basic and Advanced Quantity Surveying
- Construction Cost Planning

- Building Economics and/or Construction Economics
- Estimating and Scheduling
- Construction and Cost Management
- Project and Risk Management

Typically, in Construction Economics and Management programs students are first introduced to project financial models that are based on first principles estimating and breaking down a project into various Trades (ASMM) or Elements (NPWC/ASMM). A scheduling approach gives students the sense of construction work as a series of planned activities were resources of labour, materials plant and equipment are brought to bear on the project. Establishing a clear and realistic budget is also essential in the preconstruction stage, as is creating a schedule that realistically outlines key milestones and deadlines. Scope, budget and schedule plans are best developed concurrently, as issues related to all three often correspond with one another.

A review of the Masters of Construction Management (MCM) program at University of Melbourne and particularly the subjects of the Cost Management stream of the program afforded the teaching staff in this area to revamp the teaching of Construction Cash Flows. It was found that there was a lack of emphasis on basic cash flow forecasting techniques and the understanding of the time v cost equations that are so fundamental to construction projects. In 2020 a new subject offering in the MCM program (ABPL90413 Construction Cost Planning), incorporated a dedicated one week module on basic cash flow techniques and theory. This was to be a simplified approach in teaching Construction Cash Flow Forecasting by embedding basic cash flow techniques using spreadsheets and charting for a single stage uncomplicated residential building project.

2 Literature Review – Construction Cash Flow Teaching

Student-centered approaches in teaching construction based financial models using gaming and capstone projects are evident in the academic literature (Shim et al 2013). Smit & Coffey (2009) developed a cash flow & interim valuations module as part of a final year core Construction Management subject at Queensland University of Technology using simulation software. In this subject student were introduced to a United States (US) developed organizational culture survey instrument which included spider graph charting similar to charting features of MS Excel. The UK based version of the building simulation game AROUSAL (Lansley, 2018) was then introduced to these students during week 8 and the software was demonstrated, and briefing documents handed out and students self-organised into groups sized between 8 – 10 persons. Students were tasked with a group assignment including oral presentation of their results.

It has been found the whilst the non-bespoke or common spreadsheet method provides only an introductory and elementary understanding of cash flow statement construction, its ease of use encourages an earlier presentation in the classroom and supports the efforts by educators to provide a balance between users and preparers of financial accounting information (Brickner and McCombs, 2004). Students may struggle to understand the indirect method of modeling cash flows (Vent and Cocco, 1996) because the method of constructing the cash flow statement is not intuitive (Hodder, Hopkins, and Wood, 2008). This was evident in Smit & Coffey's subject experience where they introduced a more user-friendly version of the spreadsheet software and automated charting function in which students appeared to be able to work with much more easily than the initial program.

It is worth noting that the AROUSAL program that has been used by Construction educators since 1982 has ceased according to its creator Dr. Lansley, who stated that "*After 33 very successful years, in 2018 I ceased running AROUSAL courses for industry and universities and issuing software licenses for the use of AROUSAL*." Several competitions based on simulation games are currently on offer to participating Construction Management students, such as the MERIT based CIOB competition and the US based American Association of Construction Educators (AACE) Regional student competitions. The MERIT acronym stands for Management Enterprise Risk Innovation and Teamwork. The simulation is designed to demonstrate the interdependence of the various managerial decisions and the interlocking nature of the variables that determine the success or failure of a construction company.

While computer scheduling software can estimate cash-flows for a construction project (Kaka 1996), no software provides the complete set of capabilities needed for forecasting cash-flow at a project level: cost-loading activities, simultaneous loading of costs and contract values, and allowing the specifications of credit terms for payments. Due to the combined impacts of several factors on cash-flow, learning cash-flow forecasting requires an understanding of the factors mentioned above and their impacts on cash-flows at first. Then, students can forecast the cash-flow of a construction project (Elsey 2013). Teaching cash-flow forecasting may be performed in multiple approaches of which one is presented here.

3 Methodology – ABPL90413 module delivery and survey

This case study module is presented as an action research type classroom exercise in which the author presents an ordered narrative to share with fellow academic practitioners at AUBEA 2021. The module description that is presented in the study was delivered during COVID-19 teaching and conducted wholly online using the Canvas Learning Management System (LMS) of the university and using Zoom tutorials. It is hoped that the benefits of the methodology adopted have become obvious to the reader as the story is unfolded and the student's evaluation findings reported here.

The study employed a survey administered using the University of Melbourne's QUALTRICS survey instrument. The study was undertaken by the students of the Construction Cost Planning ABPL90413 subject, which is a 12.5 credit core subject of the Cost Management stream of the MCM program. They were invited to reply to an online questionnaire based on their experience with the week 10 cash flow module as part of the subject which has a focus on developing students cost planning knowledge and skills. Students were asked to answer eleven questions. Participants were recruited from the enrolment list within the Canvas Learning Management System (LMS). The link to the online survey was sent to all enrolled students with the study's objectives. Participants were made to understand that their consent to participate was implied by submitting the survey and that the survey was voluntary.

4 ABPL90413 Cash Flow Module

The week 10 Cash Flow module follows a conventional approach to incorporating lecture content and tutorials delivered in online mode. Teaching and learning tools of the LMS and Zoom tutorials use break out rooms and chat features for Q & A during the tutorials which facilitate student interactions and guide students in assimilating the content and gain competency in modelling and manipulating project financial data using spreadsheets under the guidance of their lecturer and tutor (see fig. 1 below). A supplementary short weekly online quiz was available within Canvas providing formative assessment of a student's learning and comprehension.

- Activity 1: Download and review the week 10 topic Presentation slides here
- Activity 2: View the weekly lecture presentation here

- Activity 3: Attend the online tutorial and complete the tutorial exercise (see Tutorial Module)
- Activity 4:Take the Practice quiz for week 10 link here
- Activity 5: Complete the module reading prior to the lecture

Figure 1. The dashboard in LMS for week 10 cash flow module.

2.1 Understanding of the performance of building contracts and the lazy s-curve

Students in any Construction Management degree learn early on, that a construction project involves progressive payments related to progress of the works over a lengthy time period. They learn also that for construction project financing it is unrealistic to expect the contractor to fund the whole works from their 'own pocket' to be paid only a lump sum on completion. Fundamentally and irrespective of the procurement route, until the main contractor has been appointed, client cash flow projections are likely to be based only on agreed fee payment schedules for consultants and a simple division of the construction cost over the likely construction period (or perhaps an allocation of construction cost over an s-curve distribution).

This basic modeling approach is an excellent mechanism by which students can develop schemas that increase their ability to assimilate and interpret financial statements (Hodder et al., 2008). Other subjects in Procurement and Contract Management delve more deeply into 'bespoke' or alternative funding arrangements that might occur on large private partnership projects or speculative developer lead projects. (Aranda-Mena, G. and Vaz-Serra. P. 2019). This is where more sophisticated cash flow models and projections can be taught to students.

2.2 The EXCEL spreadsheet as a model tool for cashflows

The method proposed for teaching cash flow formulation to the ABPL90413 students sought to minimise issues identified as creating problems or learning obstacles (refer sect. 2 of paper) by reducing the complexity of the task using basic Excel spreadsheet techniques. As part of the suite of Microsoft Office programs Excel familiarity is expected in university education and all students are given Microsoft Office 365 accounts. Nonetheless, the supplementary reading and guidance notes for students encouraged wider reading and engagements in this area such as;

- '**Excel for Dummies'** is a popular electronic resource running to some 801 pages, aimed at beginners with tips Getting to know your way around Microsoft Office Excel begins with launching the start-up window and learning the functions of the Excel Standard and Formatting toolbars to create and manage your spreadsheets.
- **Youtube** provides an almost unlimited array of Excel tuition videos on a range of features of the program. This has grown almost exponentially each year of the several decades that Excel has been the dominant spreadsheet program and Youtube has become an open source of these tuition videos.
- **Vimeo and Slideshare** are less widely known and used as Youtube however contain a range of academic style presentations, some limited construction and cash flow related topics incorporating spreadsheet analysis techniques.
- **LinkedIn Learning** an American website offers video courses taught by industry experts in software and business skills. The ABP Faculty at UoM had bought a subscription to the online learning environment. Cash Flow is a rich source of content with various Instructors and modules on such topics as 492 Results for "cash flow" there are 24 separate courses listed, typically courses are in video presentations of 1 – to if 3 hrs.

This wide array of external content could be potentially overwhelming for a Construction student so caution and a focussed approach to searching for extra support material was encouraged. Neither should these resources be considered outsourcing of program teaching as the subject had its specific learning objectives in tailored lectures and two hour long weekly tutorials and summative assessment of the learning areas in examinations. Perhaps the value in resources such as LinkedIn Learning and Youtube videos is to provide students with additional help in understanding the features of the Excel spreadsheet program and use this under instruction to produce their cash flow and S curves.

2.3 Steps to generate a basic spreadsheet cash flow

The steps outlined in this section mirror the workflow of students engaged in the online tutorial. The financial data is based on a predicted cash flow for construction of a residential project that they have developed a full cost plan in the earlier week's modules. Extracting the elemental budget from the CostX onscreen measurement and estimating program. An educational institutional or student version of CostX comes with restrictions which relate to the Import and Export of data. There are no exports of data from workbooks to any external formats such as Excel and CSV.

The entire schedule cannot be copied to the clipboard however individual rows, columns or cells can in a user-friendly way. Whilst a 'Drag and Drop' of Dimension Groups in CostX to Excel is a disabled feature in the educational software, it is a relatively easy task to open the workbook and Cut and Paste the relevant cells of a Workbook summary and in one go capturing the data into an open Excel worksheet. It is important when pasting the cells to import as 'Values' rather than a Cell formula or a transposed array.

Step 1: Cash values are derived from the Cost Plan tutorial file which they have developed and priced in earlier modules of the subject and for which an assignment has been undertaken. The Elemental Workbook in CostX is used (see fig. 2 below). Students can cut and paste the rows and columns to Excel, the quantity unit and rate columns become redundant in the cashflow spreadsheet.

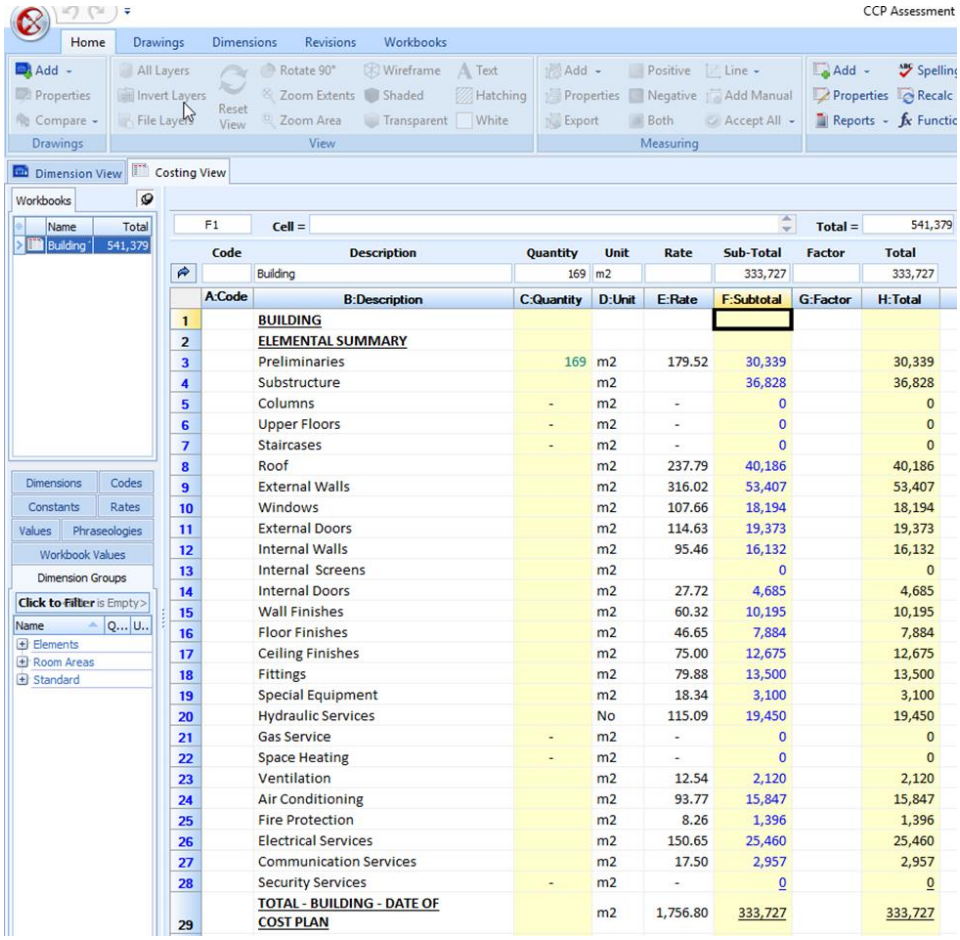

Figure 2. Tutorial Cost Plan Summary sheet used for cash flow exercise.

Step 2 The newly created workbook in MS Excel (cashflow model workbook) is opened and a column for weighted % is added to the immediate right of the element amount column. (See figure 3 below). This gives students a sense of the proportion of each element, noting that in their cost plan such elements as substructure, roof, walls and mech & elec services are of greater order cost. A cost plan in Trade format with Trade amounts could be substituted if desired.

Step 3 Once the cash values and weighted % amounts are entered, 2 further rows are added to the worksheet in figure 3 immediately after the row with total amount and total weighted percentage (100%). The first of these 2 rows are for the Total % of work in each month using the SUMPRODUCT formula applied to the array of cells in each monthly column. The second row will be used to show the cumulative percent complete each month which a calculation is based on the addition of 2 cells only, being the % completed in any one month plus the % completed in total prior months.

	Amount	Weighted %	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
4	30,339	9.09%	10%	10%	10%	10%	5%	5%	5%	5%	10%	10%	10%	10%	100%
5	36,828	11.04%		33%	33%	33%									100%
6	40,186	12.04%				33%	33%	33%							100%
7	53,407	16.00%				33%	33%	33%							100%
8	18,194	5.45%					75%	25%							100%
9	19,373	5.81%					25%	35%	40%						100%
10	16,132	4.83%									50%	50%			100%
11	4,685	1.40%				20%	30%	30%	20%						100%
12	10,195	3.05%							50%	50%					100%
13	7,884	2.36%							33%	33%	33%				100%
14	12,675	3.80%						50%	30%	20%					100%
15	13,500	4.05%						33%	33%	33%					100%
16	3,100	0.93%									50%	50%			100%
17	19,450	5.83%		20%		20%	40%	20%							100%
18	2,120	0.64%					50%	50%							100%
19	15,847	4.75%							50%	50%					100%
20	1,396	0.42%												100%	100%
21	25,460	7.63%					25%		25%	25%			25%		100%
22	2,957	0.89%											100%		
23	**333,728**	**100.00%**													
24			0.91%	5.75%	4.59%	15.38%	20.32%	18.35%	12.14%	9.16%	4.58%	3.79%	3.70%	1.33%	100.00%
25				**6.66%**	**11.25%**	**26.63%**	**46.95%**	**65.30%**	**77.44%**	**86.60%**	**91.18%**	**94.97%**	**98.67%**	**100.00%**	
26			$3,034	$19,200	$15,310	$51,334	$67,814	$61,236	$40,519	$30,566	$15,280	$12,650	$12,356	$4,430	
27				**$22,234**	**$37,543**	**$88,878**	**$156,691**	**$217,927**	**$258,447**	**$289,012**	**$304,292**	**$316,942**	**$329,298**	**$333,728**	

Figure 3. Spreadsheet of cash flow values and monthly progress amounts.

Step 4 For each element that has a cash value a % of completion in any month must be allocated. Rather than typical start and finish dates which might be derived from a Construction projects program timeline, the exercise is simplified by assuming progress in each element's construction is largely continuous and uniform (with some exceptions e.g., Electrical has a break due to 1st fix and 2nd fix considerations). Preliminaries has a 10% monthly completion in each of the first and last 4 months however only 5% in the middle four months. An explanation being somewhat higher fixed preliminaries at start up and handover/clean up.

Step 5 The projects 's' curve can be generated by the Cumulative Cash Flow array at the bottom of the sheet. Note this has been derived based on the weighted % of each element and the duration of each element across the 12 months of the project. One the cumulative cash flow array of cells is highlighted an Insert Chart function is activated and the recommended chart type is a simple 2D Line Type as shown in fig. 4 below.

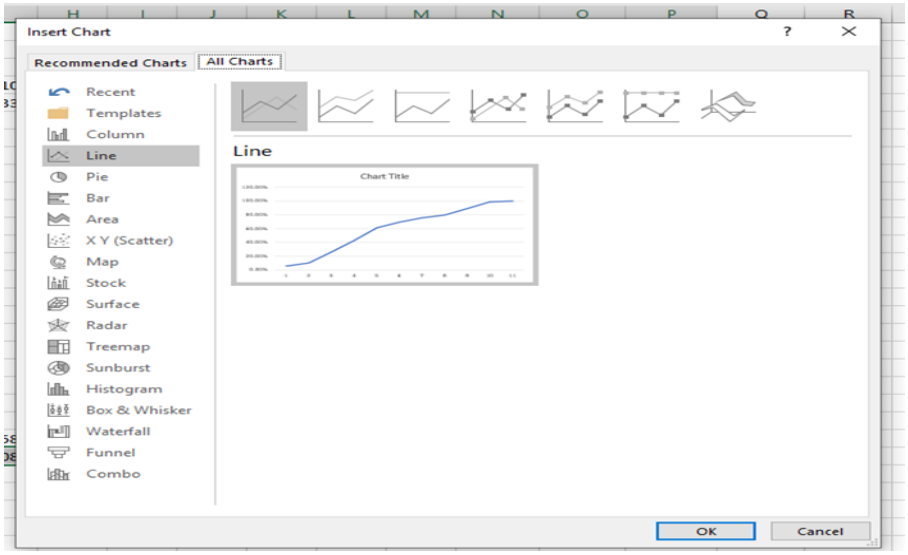

Figure 4. Index of charting options in Excel (Line chart option)

Step 6 Charting in Excel has added functionality and the Chart that exists as linked to the data in the cell array can be manipulated and labels added to each axis and can be placed in any position on the same sheet at will. Given our project time line follows a calendar month we can format the horizontal 'time' axis to shown months rather than units by using the Axis label range and point to the data array which is the monthly header on top of the sheet.

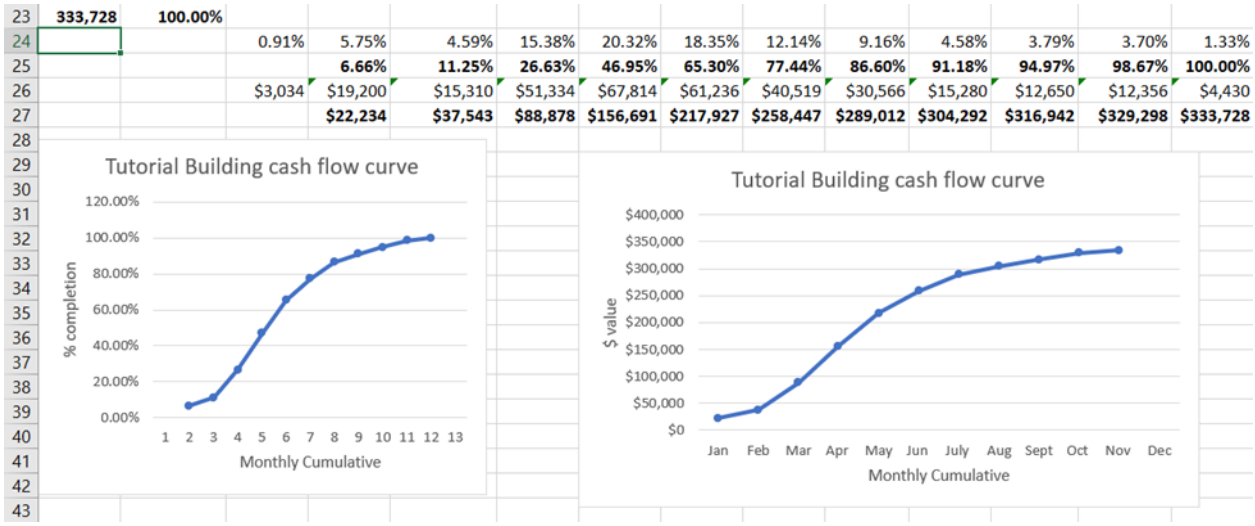

Figure 5. Applying the data in the spreadsheet to generate the cash flow curves.

Step 7 Generating a projects cash flow curve (as per fig. 5 above) demonstrates the progressive nature of expenditure. It is important to understand that whilst the 'lazy s curve which is typical of construction projects, the charting in excel can bend or stretch the curve that represents values as in the two different curves in fig. both are based on the same values however the curve on the left has shorter horizontal axis intervals and produces a more pronounced 'S' shape.

5 Module Evaluation – Student survey results and discussion

Of a student enrolment of 64 a total of 16 responses were received (25% response rate). Survey questions 5,6 and 10 are not reported here due to some vague responses and paper length limitations. The questions (in italics) with results discussions are listed in numerical order as follows;

Q 1. The question asked students *whether they took ABPL90413 as CORE subject or Elective*. 3 out of 4 students who responded were taking the subject as part of their core subjects in the Cost Management stream of the MCM program.

Q2. From the responses received to this open-ended question, *rate you prior knowledge (before taking the module) and prior skills in generating cash flow from a project tender breakdown*. Some 50% of respondents indicated they had not covered concepts of cash flow in any other subjects. Responses mentioned a specific subject taken in year 2 or 3 of the program ABPL90027 Life Cycle Analysis and Sustainability.

Q 3. *Can you please indicate which (CLICK on ANY or ALL) of these specific learning objectives were covered in week 10 cash flow module*?

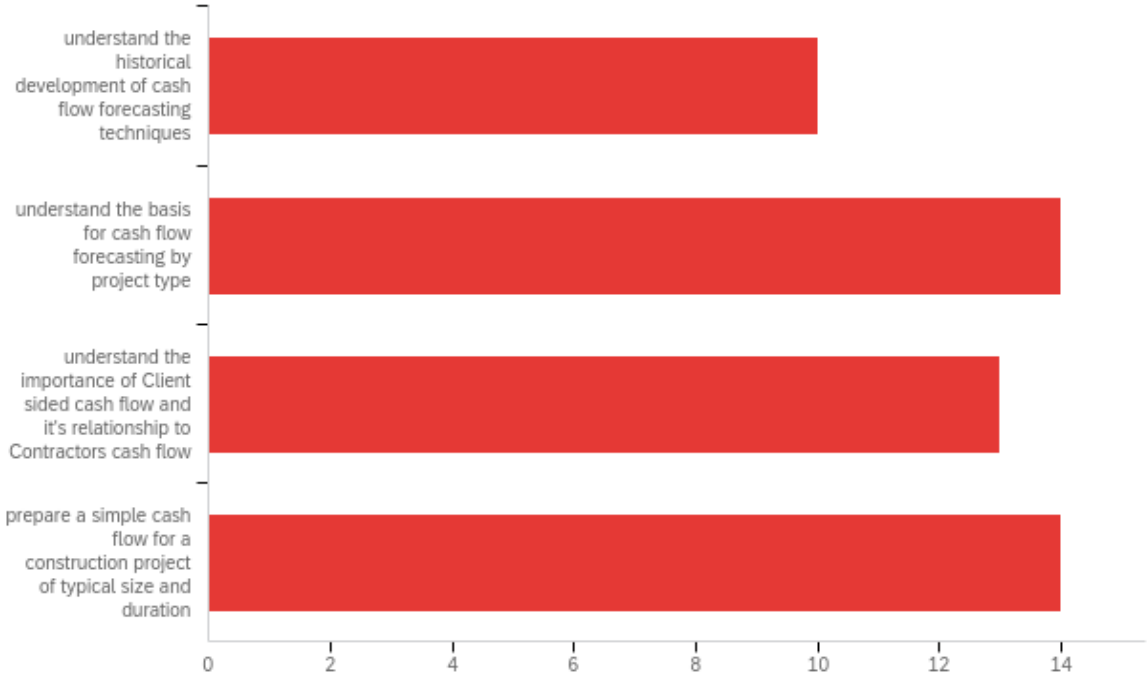

Figure 6. Responses to Question 3.

The responses as shown in Figure 6 above indicate that most students felt the intended module learning objectives were being achieved though *Understanding the historical development of cash flow forecasting techniques* was somewhat lower in coverage.

Q. 4 *In the recorded Lecture the difference between an ORGANISATIONAL cash flow and a PROJECT cash flow was outlined. Do you feel you understand this difference in cash flows***?**

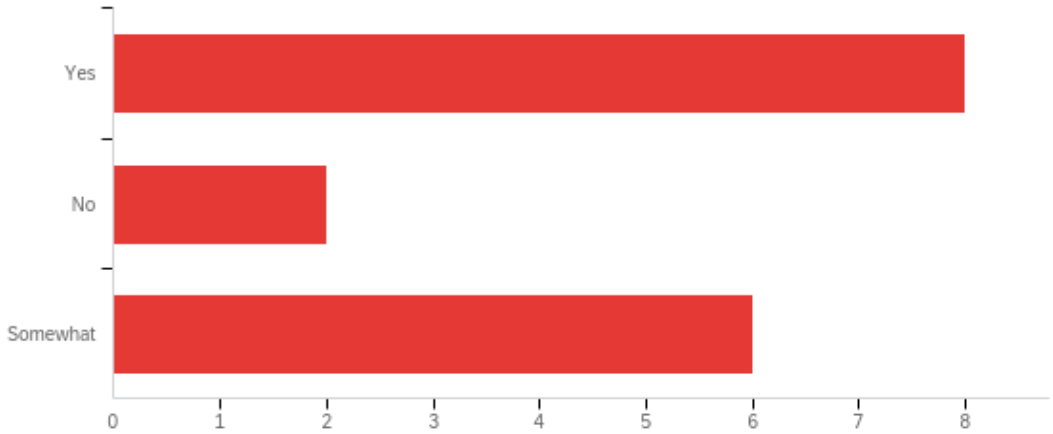

Figure 7. Responses to Question 4.

Q7 - *The Muddiest Point. What did you find a confusing point or something missing from the module?* All but one student answered NO, this student responded, *"Maybe set an example to illustrate how does cash flow work in a specific project."*

Q 8. *What (if any) supplementary EXCEL cash flow tuition have you sourced in your studies.*

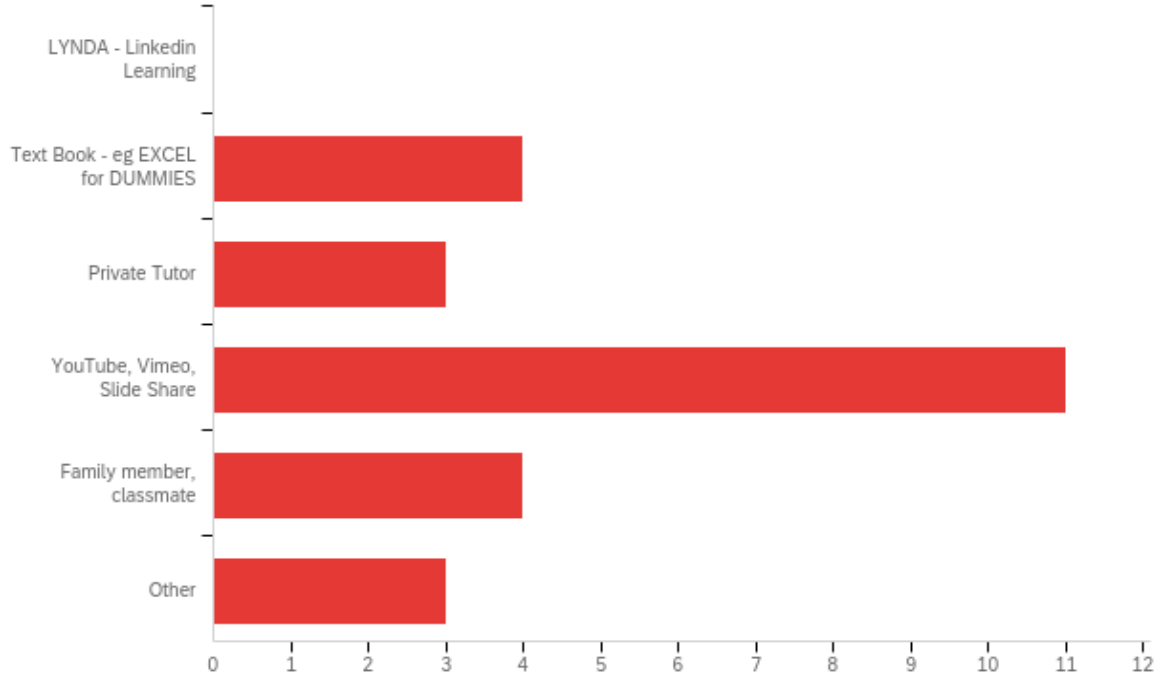

Figure 8. Responses to Question 8.

The responses to Q.8 indicate that YouTube/Vimeo/Slideshare resources on the internet are commonly used by students with some students reverting to classmates or a private tutor for further support. Interestingly no students indicated using the LinkedIn Learning platform which the Faculty makes available under a library managed subscription.

Q 9. *The online PRACTICE EXAM quiz contained cash flow questions, did you find these helpful?* The 16 responses were YES (15 no), NO (nil) and SOMEWHAT (1 no)

Q 10. Students indicate a confidence post module in their interpretation of cash flows as per, *Using the dial (1 - 10) and say how would your rate your knowledge and post module ability now to generate a monthly project cash flow from a project tender breakdown and basic project schedule.* A mean value was 7.5 out of maximum 10 (highest confidence), see fig. 9 below.

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
Using the dial (1 - 10) and say how would your rate your knowledge and post module ability now to generate a monthly project cash flow from a project tender breakdown and basic project schedule	5.00	10.00	7.50	1.62	2.63	16

Figure 9. Responses to question 10 showing Min. Max. Mean and Std. Deviation/Variance.

Q11 - *What was the key takeaway from the Module? Do you have any suggestions or comments generally?* Typical responses were as quoted below;

> *"This module was actually nice. Perhaps we need a specific cash flow example in practice and learn something how professionals prepare and work for cash flows in their projects."*
>
> *"More case studies may be effective for us to learn"*
>
> *"It builds a knowledge foundation in project cashflow for me, and thus is useful for further developed study."*

6 Conclusion

It is imperative for a university to work closely with the industry into which graduates will step out following completion of their studies to ensure that they possess the skills, knowledge and potential expertise to be immediately useful to that industry. Clearly, when teaching students how to interpret and construct a cash flow statement for the first time, a preferred method is one that reduces the intrinsic cognitive load students will face and removes, to the extent possible, extraneous factors that increase cognitive load.

The approach adopted in ABPL90413 using spreadsheets and charting simplifies the process, reduces the error rate, and allows even novice students to generate accurately predicted cash flows using typical monthly progress schedules. Based on the actual cost planning for the project covered in earlier subject modules it therefore allows students to better understand how the cash flow statement connects to the budget for the building elements. This method of teaching construction cash flows is advantageous for students because it reduces the initial complexity and extraneous cognitive loads that typically accompany their introduction to the topic of cash flow in construction. To summarize the simplicity in this method, the module that was developed:

- Presents all data in a single screen worksheet with simple rows and columns (proximity compatibility principle).
- Gives minimal instructions for data gathering, delivered directly in the worksheet (i.e., uses the original cost plan which students are familiar with and set % allocations of anticipated progress in each element).

- Uses only seven steps in a logical and iterative process to convert balance sheet budget amounts from the cost plan estimate to a monthly cash flow basis (reduced complexity).
- Uses standard cell referencing and only one more advanced formula SUMPRODUCT in Excel, to convert balance sheet expenditures to monthly cash basis (reduced complexity).
- Makes use of a visual charts that illustrate the cash flow statement in graphical format.
- Provides a rapid result that allows students to more quickly arrive at the values in the cash flow statement (reduced complexity, e.g., Figures 3, 4 & 5).
- Readily facilitates the understanding of basic project cash flow, time series and construction budgets and simplifies the process of categorizing them.

The key benefit of using this method in construction cost management classes has been that students can quickly model cash flows using Excel much more quickly and with much less frustration that might be with specialized accounting or project management software in only a few short steps as shown in section 4 of the paper. The result is that students can spend their time developing a better understanding of the accounts that impact their cash flow without first needing to master the structure of complicated cash flow statements. An additional benefit is that the cash flow statement created is actively linked to the elemental cost plan they created for a residential project. It also allows students to model changes to cash flow statements and directly see the impact on the cash flow statement within Excel.

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