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A novel framework to transfer credits of computing courses on the basis of knowledge units in higher education institutions

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Abstract: It is common practice for students that they transfer their study program from current department, college or institution to another entity. During transfer of a program students wish to transfer credits of their completed courses to other institution. It is important that the knowledge and skills obtained from a transferring institution meet the standards of the receiving institution. Sometimes it is difficult to map the courses in two different institutions due to vague course descriptions and learning outcomes; as a result, the course credits evaluators either approve or deny credit transfer request. In both situations students face difficulties coping with higher level course. Traditionally, it is suggested to find out the course outlines and learning outcomes of a course and then equalize the course. This traditional process does not give due course credits to students as learning outcomes or outlines of a course may be different among institutions. In this study, descriptive methodology employed quantitative approach to collect data through a simple questionnaire from university students. We have presented a framework which will help higher education institutions to determine equivalence credit hours of computing courses based on knowledge units of a program rather than course learning outcomes. The framework is validated by the data obtained by conducting interviews with university students which affirm the usefulness of the model to both students and institutions.

Keywords: *Credit transfer, Equivalence framework, Higher education, Learning outcomes, Transfer student.*

1. Introduction

In higher education institutions it is a common practice where students change their program due to lack of interest in it or demand in industry of a program. Each institution has its own number of credits hours of a 4-year bachelor of science program in computing field which students must complete to be graduated. Usually, in Saudi universities the minimum number of credits hours in a 4-year computing program is 120. Students who initially register in one program may wish to transfer the program in another department or college of the institution or even another institution. Sometimes, students transfer their study either from one department to another department or from a community college to a four-year degree program at a university [1].

Haldane and Wallace [2] describe transfer of course credits as an important process where the partially completed qualifications are given suitable credits to students to continue their study in another department or even another institution. Some universities may accept transferring students in their program based on the relevant courses and course titles they complete in transferring institution. For example, when students decide to change Computer Science program to Information Systems

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program or vice versa, only relevant courses are equivalized and credit hours are awarded without evaluating the knowledge and skills obtained by those courses. However, some institutions map the course outlines and course duration to equalize course credit hours. It is noticed that without detailed and insightful assessment of a transferred course, giving equivalence of the course becomes burden to students.

The lack of skills and knowledge required to progress with the new program or courses stems problems to students and causes for mental stress. In such situations albeit students strive to make up their skills and knowledge with the tools and techniques required to progress in the program in receiving institution, they end up with either drop higher level course or show low performance [3]. In addition to these problems, the credits transferring procedure is a tedious and time consuming to students which requires movements from one office to another. Usually, students fill a paper form to transfer credits and submit it along with transcripts to academic advisor responsible to check credentials. Then, after some corrections (if needed) the form is passed on the relevant department for a review which may require some correction or data and return form to the advisor. This process may require a significant amount of time [4]. Also, there is no guarantee that students would be successful in a new transferred program based on their existing knowledge obtained from the transferring institution. These are the problems that motivated us to develop a framework which could help students and institutions to determine whether course credits could be transferred.

Currently, universities adopt transfer of course credits process based on either course title to course title mapping or course learning outcomes (CLOs) to CLOs of a course. Both type of transfers cause difficulties to students. For example, in mapping of course titles, receiving institutions do not see the contents of the course being evaluated for credits, in turn, students find lack of knowledge and skills required to proceed in higher level courses. Likewise, when CLOs of a course from transferring institution to receiving institution are mapped, students may lose some of credits due to different CLOs descriptions from institution to institution. Students also lose credits when CLOs of some courses are mapped with one course in receiving institution. It is important to note that the descriptions of CLOs in receiving institution may have different descriptions of the CLOs from transferring institution. Hence, CLOs are not mapped and students lose credits in receiving institution.

This study seeks the process of transfer of credit hours of computing courses in universities and focuses on student needs to transfer course credits in full to a receiving institution. The objective of the study is to improve the process and to facilitate credit hours transfer process more transparent and rational. This study focuses on the current and traditional approaches of course credits transfer in computing program and then contributes by defining a new approach to facilitate course credits transfer among universities.

2. Literature Review

A very little literature on transfer of course credits in universities exists and its main focus has been either on administrative problems, building institutions partnership and policies [5] or capturing credit transfer experience to which students go through [6]. In literature a term recognition of prior learning (RPL) is used at large instead of credit transfer, which is more costly time consuming due to communication within and between involved institutions [7, 8]. Some universities have mutual agreement to accept course credits based on course-by-course process, but in absence of such agreement detailed reviews of documents are required including the course learning outcomes.

In order to develop a better strategy for credit transfer, technology can be used to facilitate students for credit transfer and using internet universities can collaborate with each other [9, 10]. There are different systems which have been developed to facilitate credit transfers and student movement from one program and institution to other one [11]. Such systems develop partnership, better connections and recognition of credits transfer among institutions [12]. Some systems have been devised using educational data mining (EDM) technologies to collect student data to predict student performance, but these systems have been criticized for causing wastage of time and cost in assessing prior learning [13].

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These systems, however, are useful to students to find information required to credit transfer and search courses which are transferable to other program or institution.

A European Credit Transfer and Accumulation System (ECTS) based on learning outcomes and learning process was developed that linked 143 institutions to facilitate credit transfer and student mobility. The system allows credits following completion of required work and assessments of learning outcomes [14, 15]. Similarly in California public higher educational system, a system ASSIST [16] has been developed to facilitate students to transfer credits across institutions. The credit transfer systems in Asia were aimed to facilitate exchange undergraduate programs and to help student movement internationally [17]. When complete information for credit transfer is available to students, they may successfully get transferred credits to receiving institution and could succeed in their program [18]. A system using natural language-processing based approach automates the course credits transfer [19].

Students across the world aspire to study in a program beneficial for their future and, therefore, they seek to transfer course credits. Sumitha, et al. [20] presented a strong advocacy to give students flexibility to choose courses or credits based on their interests and future prospects. Credits transfer is a global phenomenon due to mobility of students within institutions in a country or institutions across borders. However, sometimes students tend to obtain credits based on their work experience in order to get studies in high education institutions. Internationally, working students who wish to continue their study in higher education institutions as part time students; their experiential learning is formally recognized through a process known as Recognition of Prior Learning (RPL) [21]. In a study Evans [22] discussed that an RPL student has to show more significant work to obtain credits than a student works in formal courses.

Traditionally, the credit or equivalence of a course is assessed based on course learning outcomes of the course being sought for credits. In computing colleges in Saudi Arabia, the policy of course credits transfer varies from institution to institution. Some universities allow students to transfer course credits not more than the 50% of the total hours of the program [23] whereas some universities restrict students to a specific number of course credits transfer [24]. There are different terms used for transfer of course credits such as credits for prior learning (CPL), recognition of prior learning (RPL), advanced standing (AS), credits transfer (CT) etc. The purpose of all these is to recognize and equalize learning obtained from other department, college or institution for a student aspires to receive higher education. A framework for credits arrangements has been developed to award credits to engineering students with formal and informal learning and it aligns courses unit by unit [25].

In literature we found all systems to evaluate course credits are based on either matching the outlines or mapping of learning outcomes of a course. Since matching the outlines or title of course do not assess precise knowledge and skills obtained in transferring institution, students find difficulties to understand the higher-level courses due to lack of knowledge and skills. Similarly, mapping of learning outcomes does not award complete credits of a course as the descriptions of learning outcomes in a transferring institution may be different than the receiving institution and hence full credits are not awarded. In both cases students are disadvantaged and may find difficulties in higher level courses.

We have reviewed descriptions of some computer science courses in different universities of Saudi Arabia. Table 1 shows sample of course learning outcomes of a programming course of Computer Science program in different Saudi universities [26-29].

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Table 1.
Comparison of course leaning outcomes in universities.

Institution	Course title	Level	Credit hours	Course learning outcomes
Imam University	Computer Programming 1	1	4	- Edit, compile, and execute computer programs. - Trace computer programs. - Debug computer programs. - Write readable programs using coding conventions such as comments, indentation, and naming. - Solve problems by using structured programming techniques: sequence, selection, and repetition [27]
Taibah University	Programming 1	1	4	-Solve problems algorithmically - Identify the basic concepts of OO programming - Explore the concepts of access control, encapsulation, inheritance and polymorphism in programming using the Java language - Develop skills in designing, implementing, and testing programs in Java language based on OO concepts [28]
King Faisal University	Fundamentals of Programming	2	4	- Analyse the requirements for solving basic computing problems and design suitable algorithmic solution - Design and implement programs that use fundamental programming constructs - Analyse and explain the behavior and output of simple programs involving fundamental programming constructs - Test and debug programs that use the fundamental programming constructs [26]
Majmah University	Programming 1	3	4	- An ability to apply knowledge of computing and mathematics appropriate to the program's student outcomes and to the discipline - An ability to analyse a problem, and identify and define the computing requirements appropriate to its solution - An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs - An ability to function effectively on teams to accomplish a common goal [29]

The course titles of programming courses almost same such as 'Fundamentals of Programming', 'Introduction to Programming', 'Programming 1' or 'Computer Programming 1'. The syllabuses of all these courses, however, focus on problem solving, program structure, design and implementation but, the vocabulary used for CLOs found different in each of the courses [26-29]. When students plan to transfer from one university to another university, they seek exemption of Programming 1 course in order study to higher-level programming course. An evaluator to decide course credits may not give exemption of the course due to absence of the vocabulary of core concepts in the CLOs and students would be required to take Programming 1 course again. In another scenario, students may get exemption of the course but may face difficulties in the higher-level course due to lack of knowledge and skills required to continue in the course.

In order to resolve such issues and problems, there is a need to develop a holistic approach which could help students to determine whether transfer of credits is useful and they could continue further studies in receiving institution without difficulties.

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3. Methodology

In this study descriptive research design is used which helps to collect and analyse data of any specific topic of interest. In the current study, the topic of interest focuses on the issues and difficulties students face in Saudi universities during course credit transfer from one institution to another. Since the main objective of this study to discern such trend in higher education institutions and to propose a viable approach to address issues, we selected the descriptive research design. Quantitative method employed to collect data through a survey instrument. In order to collect data, we devised a simple questionnaire comprising of five questions. The focus of questions was to know whether students are satisfied with the credit transfer process in the universities and aspire to replace it with a viable framework. We approached to the undergraduate students outside the admission and registration department of the universities and ensured the students experienced credit transfer process at some stage in the university. We explained the purpose of the study and after their consent questionnaire was provided upfront which they completed in less than five minutes. Table 2 shows sample of the questionnaire where SA = 'Strongly Agree', A = 'Agree', N = 'Neutral', A= 'Agree' and SD = 'Strongly Disagree'

Table 2.
The items of the questionnaire.

Items
The current course credit transfer process in the university is just and efficient
The current credit transfer process is time consuming and exhaustive
In one of my transferred courses the course credit hours were partially accepted by the university
There is a need of a structured credit transfer system to facilitate transferring students
The proposed course credit transfer framework might be a useful to students and universities

The data collected was coded in Microsoft Excel sheet. For complete statistical analysis we used different techniques and the results are shown in the next Results and Discussion section.

As stated above, course credits are awarded based on policies of individual institution; some universities accept course credits based on course outlines and grades obtained in the course. Some universities focus on the course learning outcomes which vary from institution to institution. Currently most of the institutions evaluate course credits based on learning outcomes.

Course credit transfer is time consuming and costly process. Students face difficulties to transfer course credits from one department, college or university to another institution. In view of such issues, we have developed a framework which could help students and institutions to transfer course credits

3.1. Proposed Framework

The Education and Training Evaluation Commission (ETEC), Saudi Arabia was established in 2018 as an independent body directly linked to the Prime Minister. The major role of the commission is to measure, assess and give accreditation to public and private education and training institutions. The main objectives of the Commission include to enhance performance and outcome of student learning, develop quality of professionals in education and training sectors and to support institutions in such programs. In order to develop high quality academic program, the commission has prepared specialized academic standards to set minimum curriculum requirements of an undergraduate program in Computing field such as Computer Science, Information Systems, Data Science, Computer Networking, Artificial Intelligence etc. [30].

According to ETEC standards there are knowledge units namely (1) general knowledge unit (KU-G), and (2) specialized knowledge unit (KU-S). Each knowledge unit embodies various related topics and the topics cover curriculum contents. There is a set of learning outcomes in each knowledge unit which are covered by the program learning outcomes (PLOs). One PLO may be mapped with one or more KU-G. Each of the knowledge units has program related topics that are essential for a program and assessed

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by learning outcomes. CLOs of a course may be linked directly with one or more KU-G explicitly or implicitly through KU-S.

In the wake of the standards, rules and guidelines developed by ETEC, we have developed a framework to facilitate transfer of course credits from one institution to another institution. Figure 1 shows the proposed framework based on the knowledge units.

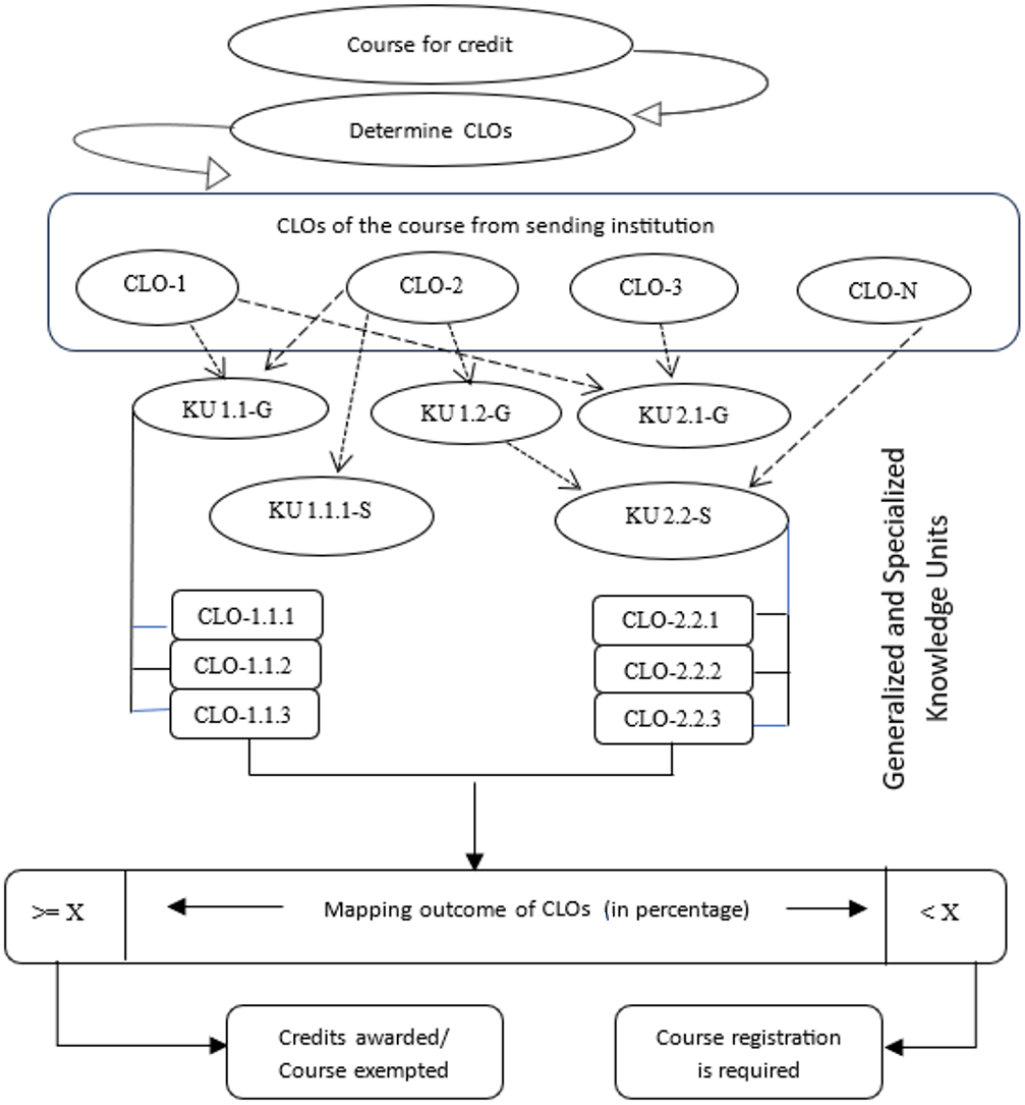

Figure 1.
Proposed framework to transfer course credits

When student submits courses for transfer of credits to a receiving institution, the course learning outcomes of the courses are determined. Each of the CLOs has to be mapped in each of the categories of the knowledge unit i.e. KU-G and KU-S. A KU-G has a general description in specific area which consists of certain percentage in a program. Further, this KU-G (and its percentage) may be distributed in one or more KU-S. For example, a KU-G in System Development area may have three KU-S as Analysis and Design, Application Development and Programming. The percentage of KU-G of the System Development is distributed among the three KU-S which have respective CLOs in the

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receiving institution and can be mapped with the CLOs of the transferring institution. If the mapping of the CLOs is equal or more than the pre-defined percentage of receiving institution then the course credits or exemption awarded otherwise students have to register in the course to proceed higher level courses.

A learning outcome of the course from sending institution may be mapped with more than one knowledge units. A knowledge unit is identified based on the topics from the course being sought for credits. Therefore, it is possible that topics of a course may exist in more than one knowledge units. Contrary to the traditional mapping of CLO to CLO of a course, this new approach helps to determine student knowledge and skills gained in different courses. Each of the knowledge units has a set of course learning outcomes in the receiving institution which are mapped with the CLOs from sending institution. Once the mapping of CLOs from the sending institutions with the knowledge units is complete, the percentage of mapping is calculated. Receiving institutions may set a percentage of CLOs to be mapped before credits can be accepted. The value of X in the framework varies from institution to institution. Many universities set this value higher than 70% for exemption of the course and the course lower than this value has to be registered in the receiving institution. The great benefit of this approach is students gain full credits of their knowledge and skills (due to knowledge units) and do not lose any credit due to different descriptions of CLOs in institutions. The framework also ensures that students have the required knowledge and skills to proceed in the higher-level courses without any difficulties.

4. Results and Discussion

We personally contacted to the students outside the admission and registration office in four different universities in Saudi Arabia and ensured the students experienced credit transfer process at any stage in the university. We explained the purpose of the study to the students who agreed to fill in the simple questionnaire anonymously.

We collected data from 161 students at three levels i.e. Level-1 (first year students), Level-2 (second year students) and Level-3 (third year students) registered in four different universities in Saudi Arabia. We prepared a simple questionnaire for the students to get their feedback about the current credit transfer process and potential of a structured credit transfer system. In the questionnaire first we collected student demographic data and then five simple close ended questions were provided each on Likert's scale (1-5). Table 3 shows the demographic information of the participants.

Table 3.
Demographic data of the participants

Age	**Male**	**Female**
<20	42 (26.0%)	71 (44.0%)
20-22	18 (11.1%)	15 (9.3%)
23-25	10 (6.2%)	5 (3.1%)
Level	Male	Female
Level-1	35 (21.7%)	52 (32.2%)
Level-2	27 (16.7%)	32 (19.8%)
Level-3	8 (4.9%)	7 (4.3%)
Total	70 (43.4%)	91 (56.5%)

Students in Level-1 (first year in university) are in large number who had experience of credits transfer from another institutions. Majority of the students were female and most of the students were less than 20 years of age. However, in Level-2 (second year in university) a smaller number of students transfer their credits and the reason seems their adjustment in the selected program. There are very few students in Level-3 (third year in university) who transfer credits to another department, college or institution.

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The main aim of the questionnaire was to focus on and to get responses of two items related to i) the current process of course credit transfer and (ii) expectation of a new credit transfer system in future. Table 4 shows the data obtained on Likert's scale (1-5) in response to the following statement:
'*The current course credit transfer process in the university is just and efficient*'

Table 4.
Participants' responses studying in different levels

Level	Gender	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
Level - 1	Male	3 (1.8%)	5 (3.1%)	1 (0.6%)	16 (9.9%)	10 (6.2%)
	Female	5 (3.1%)	7 (4.3%)	2 (1.2%)	27 (16.7%)	11 (6.8%)
Level - 2	Male	1 (0.6%)	2 (1.2%)	1 (0.6%)	15 (9.3%)	8 (4.9%)
	Female	3 (1.8%)	5 (3.1%)	2 (1.2%)	16 (9.9%)	6 (3.7%)
Level - 3	Male	0 (0.0%)	1 (0.6%)	0 (0.0%)	4 (2.4%)	3 (1.8%)
	Female	0 (0.0%)	1 (0.6%)	1 (0.6%)	3 (1.8%)	2 (1.2%)

There were 70 males and 91 female students in different levels who participated in the study. Table 5 shows their data more precisely

Table 5.
Total participants responses

	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
Female	8 (4.9%)	13 (8.0%)	5 (3.1%)	46 (28.5%)	19 (11.8%)
Male	4 (2.4)	8 (4.9%)	2 (1.2%)	35 (21.7%)	21 (13.0%)
Mean	2.273292				
STDEV	0.337736				

The data in Table 5 shows that 75% students were unsatisfied with the current credit transfer process in the universities. In all the participants, 40.3% female students showed their dissatisfaction on the current credit transfer process in the universities whereas 34.7% male students also showed their dissatisfaction. The mean value 2.273 is within the range of 1.81-2.62 which corresponds to 2 on Likert's scale, in turn, the participants do not agree with the current equivalence course credits transfer process. Also, the standard deviation confirms the respondents' dissatisfaction on the prevailing credit transfer process in the universities.

We explained the proposed credit transfer framework to students in detail so that they could provide their feedback in response to the statement in the questionnaire. Table 6 shows the data obtained in response to the following statement:
'The proposed course credit transfer framework might be useful to students and universities'

Table 6.
Participants' responses about proposed framework

Level	Gender	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
Level - 1	Male	14 (8.6%)	17 (10.5%)	2 (1.2%)	2 (1.2%)	0 (0.0%)
	Female	20 (12.4%)	28 (17.3%)	3 (1.8%)	1 (0.6%)	0 (0.0%)
Level - 2	Male	8 (4.9%)	15 (9.3%)	2 (1.2%)	2 (1.2%)	0 (0.0%)
	Female	11 (6.8%)	17 (10.5%)	1 (0.6%)	3 (1.8%)	0 (0.0%)
Level - 3	Male	2 (1.2%)	6 (3.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Female	3 (1.8%)	4 (2.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

The data shows a large number of students favoured and agreed with the proposed credit transfer framework in order to facilitate students and universities. Table 7 shows more precise data

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Table 7.
Total participants responses about proposed framework

	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
Female	34 (21.1%)	49 (30.4%)	4 (2.4%)	4 (2.4%)	0 (0.0%)
Male	24 (14.9%)	38 (23.6%)	4 (2.4%)	4 (2.4%)	0 (0.0%)
Mean	4.211180				
STDEV	0.938276				

The data shows almost 90% participants favoured and agreed to the proposed credit transfer framework. It is noticed more than 50% participants were female students who agreed with the proposed framework. It is understandable with the number of female students who seems unsatisfied with the prevailing credit transfer system. The mean value 4.2111 is within the range of 4.21-5.0 which corresponds to 5 on Likert's scale, in turn, participants overwhelmingly in favour of the framework and agreed with the proposed framework.

The Figure 2 describes the responses of the students from different levels.

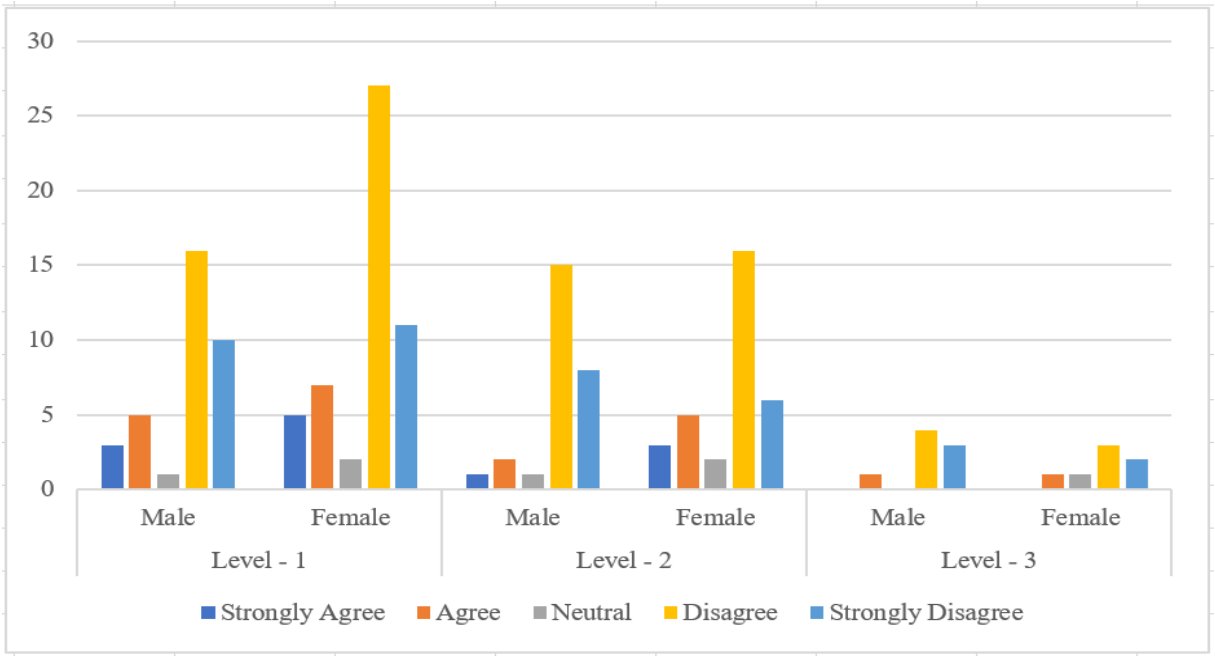

Figure 2.
Student feedback on credit transfer satisfaction

It is evident that mostly students especially female students were unsatisfied with the course credit transfer in the receiving institution. The reason for their unsatisfaction was that some, if not all, the female students showed specimen of their course work as evidence from transferring institution to claim course credits. Usually level-1 students aspire to transfer maximum course credits in the receiving institution and become reluctant when they receive undesired credit transfer and take extra courses in the receiving institution. The reason seems to be different description or vocabulary of course learning outcomes in the receiving institution.

Figure 3 describes the responses received from students following explanation of our framework to them.

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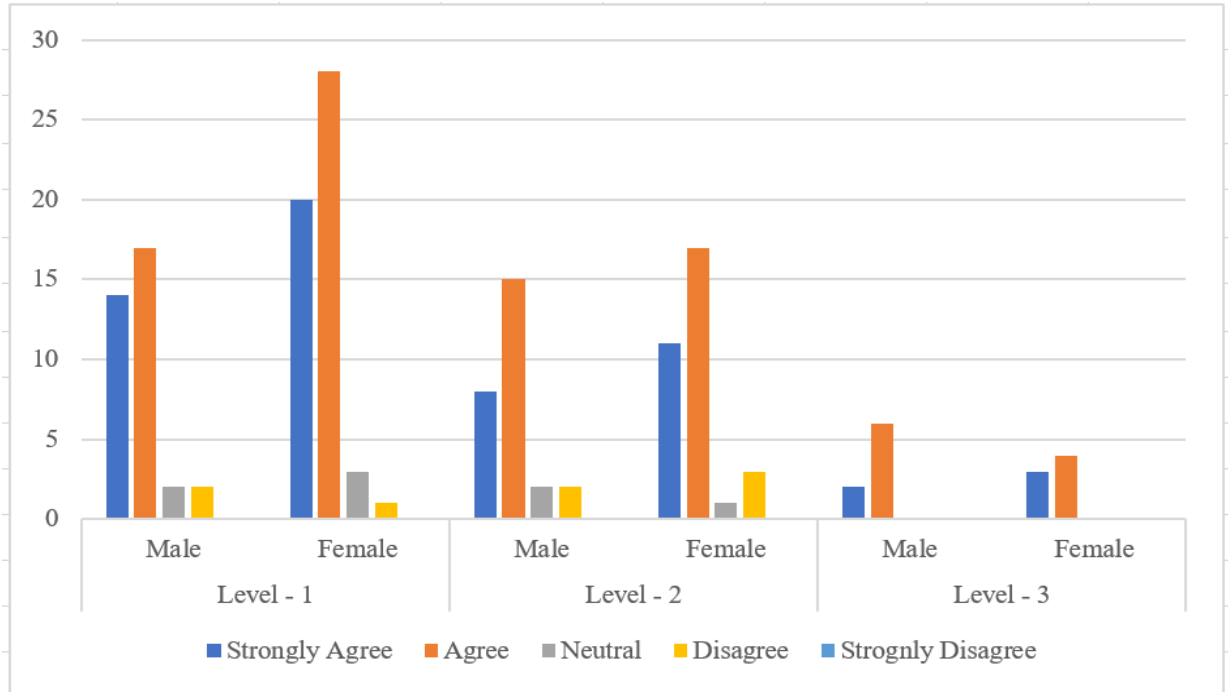

Figure 3.
Student feedback about proposed framework

It is depicted that students are more satisfied with the framework and majority of students agree that the framework will be useful to transfer course credits transparently in receiving institution. The number of female students in each level is higher than the male students; and the reason is the growing number of female students in almost every program across Saudi Arabia and their participation in research study.

5. Conclusion

In view of student difficulties in transferring course credits in computing programs, we developed a framework according to the standards and rules defined by ETEC, Saudi Arabia. The framework is based on knowledge units which helps to map CLOs of courses from transferring institution to see whether the CLOs map with one or more KU-G which may be linked with one or more KU-S. Each of the KU-G and/or KU-S has direct link with CLOs of courses in the receiving institution which can be mapped with the CLOs of courses from transferring institution. The percentage of mapping is defined by receiving institution and it is equal or greater than the defined percentage then course credits are awarded to student. The research provided the answer of our research question that a structured framework can help to equalize computing course credits. The framework will fairly evaluate their learning, knowledge and skills in the receiving institution and prevent losing any credit. The framework will cover all the knowledge and skills students obtain in their institution before transferring to a receiving institution. Students cannot lose any knowledge they obtain in any of the courses toward their program which is great benefit of this framework. In future, we intend to develop a program/tool which could validate the framework and determine efficacy of the framework.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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