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## Teaching java programming on smartphone-pedagogy and innovation; proposal of its ontology oriented implementation.

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### Abstract

The growth of mobile technologies was evolutionary in the progression of technology, it opened a revolution in computing in a quicker time frame. The easy availability and extreme mobility with rich set of applications made smartphones an inevitable tool for students. This is the high time for academic domain to go for innovative teaching practices with the inclusion of mobile technologies to bridge the gap between academia and industry in a considerable manner. This paper is aimed to introduce an innovative approach of learning computer programming on smartphone platform. The proposed approach intends to introduce a new pedagogy of teaching programming on a platform by developing applications instead of teaching a programming language for creating applications. The main premise of this practice is the introduction of a tailored module to teach Java programming language while developing apps for a leading mobile platform-Android. The proposed module can be an appropriate alternative for the module ‘Introduction to programming’ of computer science curriculum across the globe. Pilot implementation has been done in one of the premier higher education centres of Gulf Council Country (GCC). An ontology based implementation of the proposed module ensures its consistency in delivery and the future work will focus more in this direction.

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### 1. Introduction

Mobile devices have started a new era in computing than ever before. The evident reflection of this vital change is there in all domains including teaching and learning sector, at least in the higher education sector. The swift that

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mobile internet has been explosively done from simple mobile phones to high end smartphones made it to serve as equivalent to a mini computer or more than that with its features for teaching and learning. The easy usage and easy accessibility of smart phones, the interaction that these ubiquitous devices offered with the capability of data transfer with higher data rate made it as an inevitable tool of educators. Quite lot of researches has been done and plenty of methods that can facilitate learning have been developed for the years ranging from traditional to electronic manner. The growth of mobile technologies opened a new horizon called mobile learning (m-learning) not just as an extended version of e-learning but as an extended paradigm. The mobile devices when used for learning purpose can create more active learning experience that improve student engagement, learning and course retention (Jooston, 2010). Besides these, the use of mobile technologies enhance the motivation level of students by offering the scope of applying 'learning by doing' approach instead of learning and doing. In fact, m-learning justifies one of the popular quotes from Chinese philosopher Confucius about learning "*I hear and forget, I see and I remember. I do and I understand*". It is a fact that the paradigm of m-learning has to be well supported by appropriate teaching pedagogy for its effectiveness as well as its implementation in curriculum across the globe. Agile pedagogies are more right candidates for m-learning due to their underlying learning approach and learning element. One of the areas where m-learning can go in a deeper manner is computer science/engineering courses. Students from various engineering disciplines are very much keen on developing and even deploying their mobile applications on repositories like play store. In primitive way of teaching and learning, deployment of an application is far away from curriculum and which is considered as one of the reasons for the gap between the academia and ICT industry. Innovative teaching practices with the inclusion of mobile technologies can have the possibility to bridge the gap in a considerable manner.

This research proposes an innovative way of teaching programming on smartphone platform by deriving a tailored course 'Introduction to programming with Java on Android platform'. The derived course has been delivered to a cohort of first level programming learners with an agile pedagogy derived suiting to m-learning. In section 2, review of related works is furnished to specify the background of research. Innovative practice and learning framework is discussed in section 3. Application and Evaluation of practice is presented in section 4. Ontology based implementation possibility is covered in section 5 followed by the future work.

## 2. Related works and background of research

In recent years, the efficiency of constructivism learning method, the transition from computer based learning to web based learning and the improvement in technologies have made mobile learning one of the most popular learning styles (Yamamoto, Demiray, & U, 2010)(Yamamoto, 2011). The umbrella of mobile learning covers a wide range of its perspectives and it can be represented within any of the learning scenarios ranging from blended learning to spaced learning. Many of the older definitions of mobile learning focused more on the aspect of learner being mobile while the new smart devices and the dramatic increase in data transmission offers a more flexible view of mobile learning considering both learner and devices. The two hypotheses designed for this research and their confirmation by experiments/surveys have led to the core outcomes of this research.

Hypothesis 1: Many designers and mobile learning initiatives are converting existing e-learning courses by only resizing them to smaller screens and user interface differences.

Hypothesis 2: There is no or minimal consideration for optimizing the learning experience by leveraging the capabilities of the mobile platform by utilizing alternative approaches.

Literatures and practices have shown that the growing number of mobile innovations continue to enter the landscape, educators are now interested in to redesigning traditional learning scenarios to mobile ones that leverages the unique capabilities of the mobile platform. Being specific, learning java programming in android platform is an example of one such effort. For historical reasons, the way of learning programming have created a fear in mind of undergraduate beginners and it created unnecessary layers of learning for many students (Tigrek & Obadat, 2012). Researchers believe that the conventional way of learning a programming language from scratch to advanced level for developing applications play a major role in this direction. This makes the learning less efficient to apply in the domain of their interest and time consuming for study. Challenges for learning programming are similar for Computer Science and non-Computer Science beginners. Literatures revealed that tailored courses with examples are always interesting for the novice programmers in introductory programming courses (Forte & Guzdial, 2005).

The motivation of this paper is to create a tailored course in Introduction to Java programming on smartphone platform. This can be done by leveraging the learning curve of a new technology into a traditional programming course. A pilot survey has been conducted among a focus group to identify the mobile device used often for learning. In Fig. 1, the result of the survey represented. The chain of information in learning programming can be migrated to smartphone platform without creating another layer on top of traditional programming module.

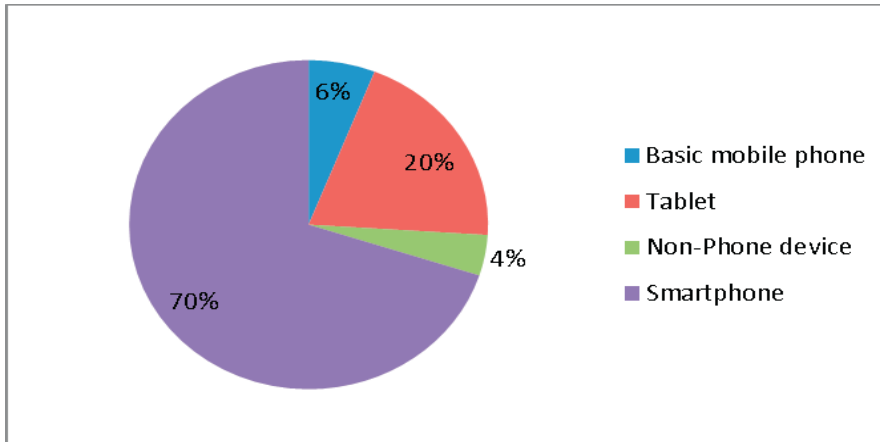


Fig.1. Mobile devices used by the students of pilot study

One of the leading mobile platforms with more apps-Android was chosen as the appropriate platform to introduce this innovative learning approach due to its rapid growth in the domain and acceptance of hand held manufacturers across the globe. ABI Research's updated market forecasts show that "The annual volume of smartphone app downloads will reach 56 billion this year". Of different OS platforms, Google's Android will account for 58% of the total, with Apple's iOS commanding an annual share of 33%. Microsoft's Windows Phone will finish the year with a slice of slightly smaller than 4%, with BlackBerry trailing it with 3%" (ABIresearch).

In a nutshell, the main premise of the proposed tailored modules to teach Java programming language while developing apps for a leading mobile platform-Android on a smartphone platform. The proposed module can be an appropriate alternative for the module "Introduction to programming", currently offered as an introductory programming module to students of various computing specializations. Through this approach, it is expected that learning programming directly on a smartphone platform will motivate the students and becomes enjoyable when they take the phone with what they have learned and share with family and friends.

### 3. Innovative Aspect and proposed pedagogy

#### 3.1. Background of practice

The innovative aspect of this research is to introduce a new style of teaching computer programming on smartphone platform. The innovation is applied to teach Introduction to programming with Java on Android platform in Middle East College, sultanate of Oman. The core aspect of this practice is to teach Java programming while developing Apps on android. This can combine two stages of learning into one stage by teaching directly on smartphone platform. The practice introduce a new curriculum under a new pedagogy which covers basic java programming skills on android platform for a novice programmer following with advanced topics which are suitable for higher level engineering and BSc (Hons) courses. The derivation of a framework for the proposed hybrid course's curriculum under an innovative pedagogy is the major deliverable of this approach which ensures the scope for developing subsequent teaching and learning materials in line with the innovative aspect.

#### 3.2. Application of the practice

The practice has been implemented on pilot study basis to a cohort of the level 2 module Internet Programming (COMP 0331.2) of Middle East College. The rationale behind the selection of this cohort and module was its java

based nature and the students of the cohort completed the traditional way of learning programming language in their elementary programming module- Introduction to programming. Students were briefed on the innovative approach for their learning paradigm shift. When introduced the concept of learning Java on mobile platform, students started paying more attention to the approach and had shown their enthusiasm especially when realized the scope of transferring their work to smartphones towards the completion. The pilot sessions conducted at one of the software labs where 30 computers with Local Area Network. Students used the computers where Computer Aided Software Tools (CASE) was installed for the smartphone application development platform.

### 3.2.1. Tools and techniques

Android mobile operating system is exclusively for devices such as smartphones and tablets. Most of the code is released under a free software license. The inclusion of such an open source mobile operating system in the curriculum can make only a positive implication in operational aspects of college. An open source Integrated Development Environment (IDE)-Eclipse is used to develop applications Fig. 2. By plugging Android SDK, Eclipse IDE can be made suitable for programming for android platform. The mentioned was set up created by students with the assistance of Student Technical Leaders (STL) in existing software lab without making any software or hardware implications. Android Development Tools (ADT) is a plug-in for the Eclipse IDE, which extends the capabilities of Eclipse developed Android applications. Tools aid to create application, to design UI (User Interface), and to debug the application. The built in emulator provides a great opportunity for the novice programmer to simulate the real device.

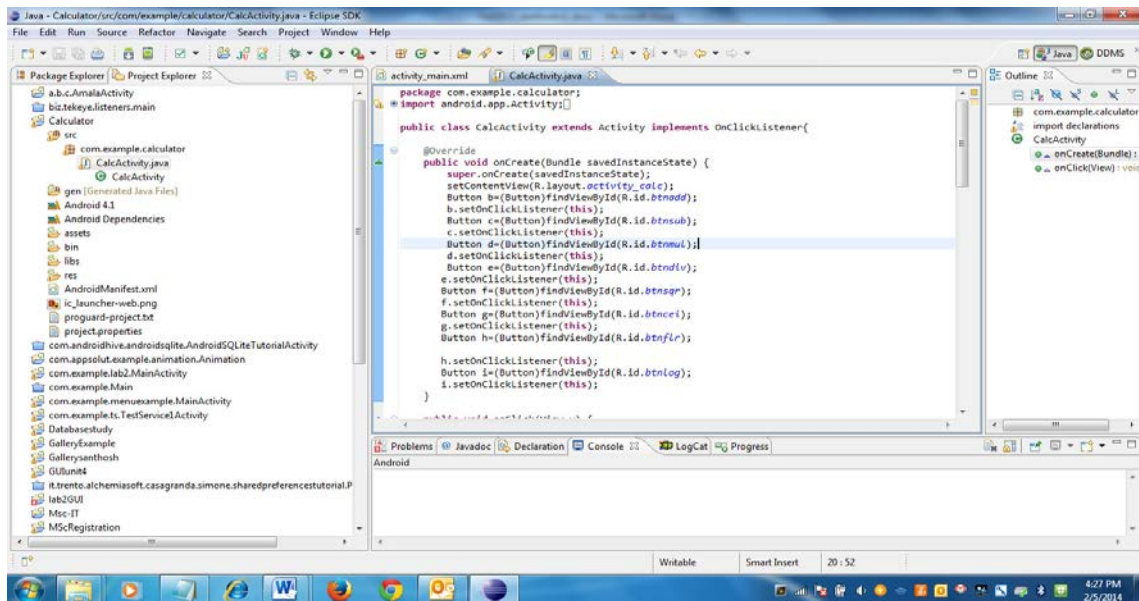


Fig. 2.Eclipse IDE with ADT

A simple calculator mobile application was developed with GUI and functionality in a single lab session on top of their introductory programming concepts. Students simulated their application on the default emulator shown in Fig.3. The students of entire cohort quickly remembered the programming features to be applied when they emulate the functionalities on a prototyping manner. Since paired programming approach was applied as part of the applied pedagogy, one noticed the flaws and missing components of the partner's coding.

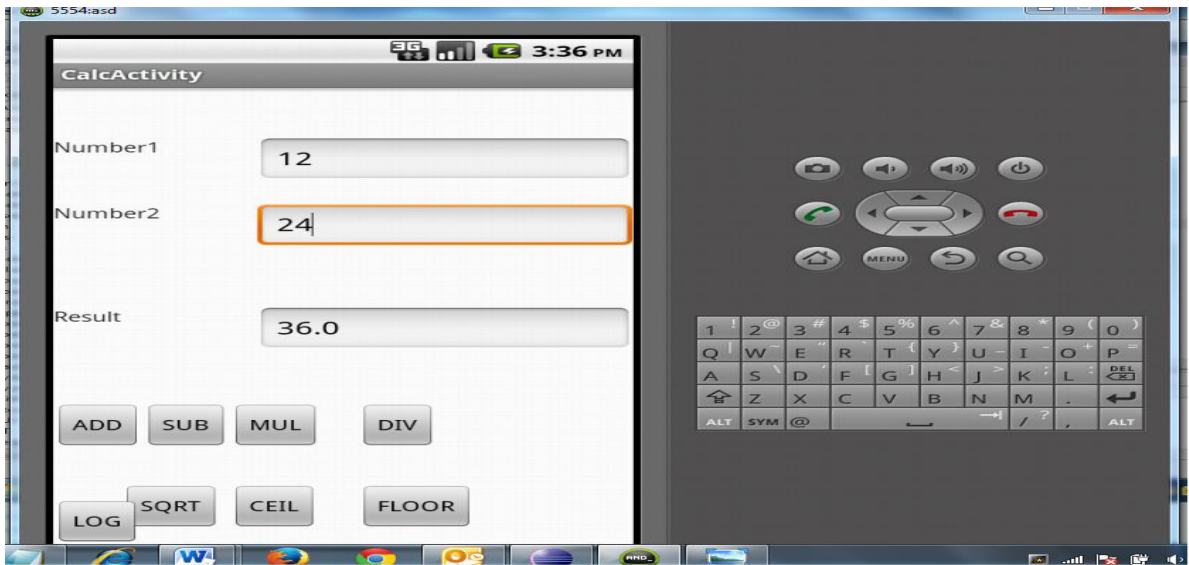


Fig. 3.Simulator view of simple Calculator android mobile application

3.2.2. Proposed pedagogy

The core of the framework of proposed pedagogy is incorporated with two components- learning elements and learning approach. Main stages of both aspects are briefed below which was applied on pilot study.

Learning elements	Learning approach												
<p><b>Introduction to programming on android platform</b></p> <p>This section includes basic programming constructs such as control structures-sequential, selection, and arrays.</p>	<p><b>Extreme programming and paired approach</b></p> <p>Agile learning approaches such as structured and guided teamwork will be part of the learning approach. Paired programming, a convenient way for programming will be incorporated. Experience demonstrated that when there is a person behind, team has more tendency to try new things and realize one’s mistake in coding.</p>												
<p><b>Object Oriented programming with Java</b></p> <p>This section covers the core object oriented programming with java on android. Android environment is rich with the libraries available. Plugged in tools that exposure to the objects will be inevitable early when working with a smartphone. It is necessary to cover conceptual material about object oriented programming (OOP) at the same point (Machanik, 2007).</p>	<p><b>Blooms taxonomy</b></p> <p>Revised Bloom’s taxonomy applied to structure the course outline, classify the exercise problems and surveys (Ari, 2011).</p> <table border="1" data-bbox="744 1208 1326 1413"> <tr> <td>Remember</td> <td>Recognize and Recall</td> </tr> <tr> <td>Understand</td> <td>Interpreting, Summarizing, Inferring, Explaining</td> </tr> <tr> <td>Apply</td> <td>Executing and Implementing</td> </tr> <tr> <td>Analyze</td> <td>Differentiating and organizing</td> </tr> <tr> <td>Evaluate</td> <td>Checking and Critiquing</td> </tr> <tr> <td>Create</td> <td>Generating and Producing</td> </tr> </table>	Remember	Recognize and Recall	Understand	Interpreting, Summarizing, Inferring, Explaining	Apply	Executing and Implementing	Analyze	Differentiating and organizing	Evaluate	Checking and Critiquing	Create	Generating and Producing
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<p><b>Adequate Java programming</b></p> <p>Java APIs that is needed for phone programming is covered in this section by concentrating on the essential patterns and keeping minimum background details. Unlike conventional traditional java courses, topics like applet, file operations, GUI development with API... this approach is pretty much in line with the fact of student’s capacity to learn is limited by the brain.</p>	<p><b>Peer teaching</b></p> <p>Peer learning with group will be implemented in a unique way. Each team will have a dedicated member for each lecture who is responsible of learning the material and teaching it to the other member. Quizzes and exams will be tracked for each problem whether the student was in teaching role or student role. This technique will be called Share Time Pair Teaching (STPT).</p>												
<p><b>Lab tutorial</b></p>	<p><b>Lab exercises</b></p>												

Tools and programming environment for Android Java. Android Development Environment (Eclipse IDE), Android SDK and deployment is the core learning element	Programming tutorials with an underlying principle ‘How’ rather than ‘Why’ to develop a conceptual model of the tools and programming environment for Android Java.
<b>Case studies</b> Case studies from the Android Developer’s site should be incorporated. These examples come with the installation and make it available in the computer for the student.	<b>Application specification</b> Application specifications will be assigned to student teams to give a bigger picture of application development in regular basis. This will have many benefits including motivation.

3.2.3. Evaluation of the practice

Qualitative observation based and quantitative questionnaire based evaluation was conducted among the students of pilot study group. It has been observed that students couldn’t even believe that platform based program learning can integrate various aspects so quickly. The proposed approach integrated GUI development, business logic development and deployment as separate components. Implicitly the students developed their mobile applications with industry standards such as component based development and application development with ‘high cohesion and less coupling’. A questionnaire which investigates feedback on four core aspects was circulated among a focus group and the results are shown in Fig 4. The practice was well accepted and appreciated.

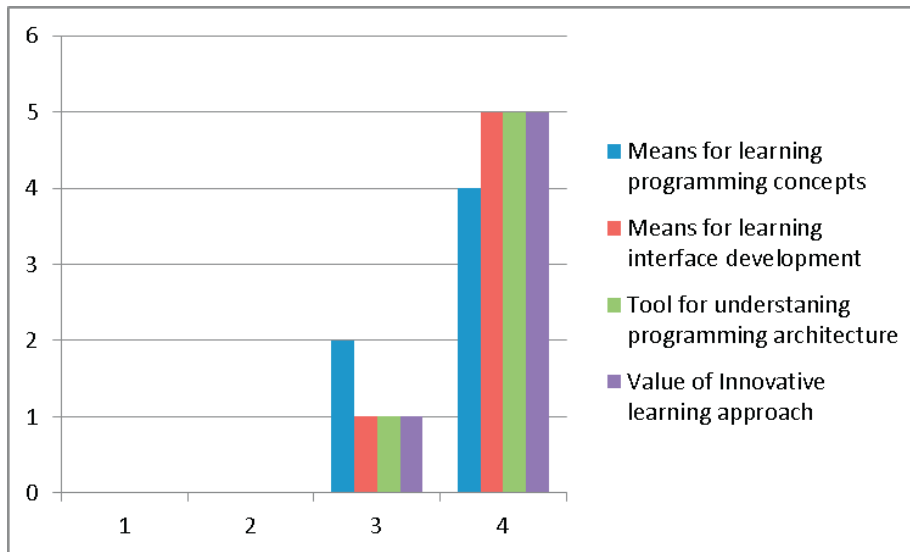


Fig. 4. Feedback analysis of pilot group

3.2.4. Recommendation of the practice

First level module, Introduction to programming offered by the Department of Computing of Middle East College to undergraduate beginners belonging to different specializations is the first full-fledged programming course of curriculum. The same module has been recommended to implement the innovative approach with an intention of introducing new mobile platform into curriculum from the beginning of engineering study. It also intended to update existing higher level engineering modules with a new mobile device and micro controller system. Since the smartphones are equipped with sensors, by connecting a microcontroller board with wireless communication to a smartphone the data acquisition by mobile platform becomes a solution without limit in engineering study and that increases the efficiency in mobile devices which can further take this practice to Augmented Reality (AR). AR technology, having developed in a very short time, has proved to be innovative and efficient technology in order to solve some kind of problems. AR can be defined as interactive device between human and computer, which has been developed by a computer in real world environment (Nee, A.Y.C, Ong, G, & Mouurtzis, 2012)

4. Ontology based implementation

An ontology based implementation of the proposed tailored course will ensure the much needed knowledge sharing

and reusability to the education domain. Ontology is recognized as a term referring to the shared understanding of some domains of interest, which is often conceived as a set of classes (concepts), relations, functions, axioms and instances (Gruber, 1993). The growth of e-learning and computer based educational systems should support the import and export of knowledge in a standard format with common semantics. Ontology can be used as a skeletal foundation for a knowledge base. One of the motivations to build ontology for Introduction to Java programming with Android is connected with the attempts to create more effective teaching strategies by unifying the different views on the domain. As of now, different teachers introduce Java programming based on many different parameters of their own, such as the order of topics, emphasis on concepts. Though the order in which the teacher presents the material is up to him/her, the basic hierarchical link structure is not violated provided an ontology based approach is followed. Researcher proposed a hybrid methodology for ontology development derived from traditional software engineering process models and tools (John, 2010) followed in one of his previous publications. Fig 5 illustrates the framework followed for the proposed implementation of the tailored course derived from the innovative approach.

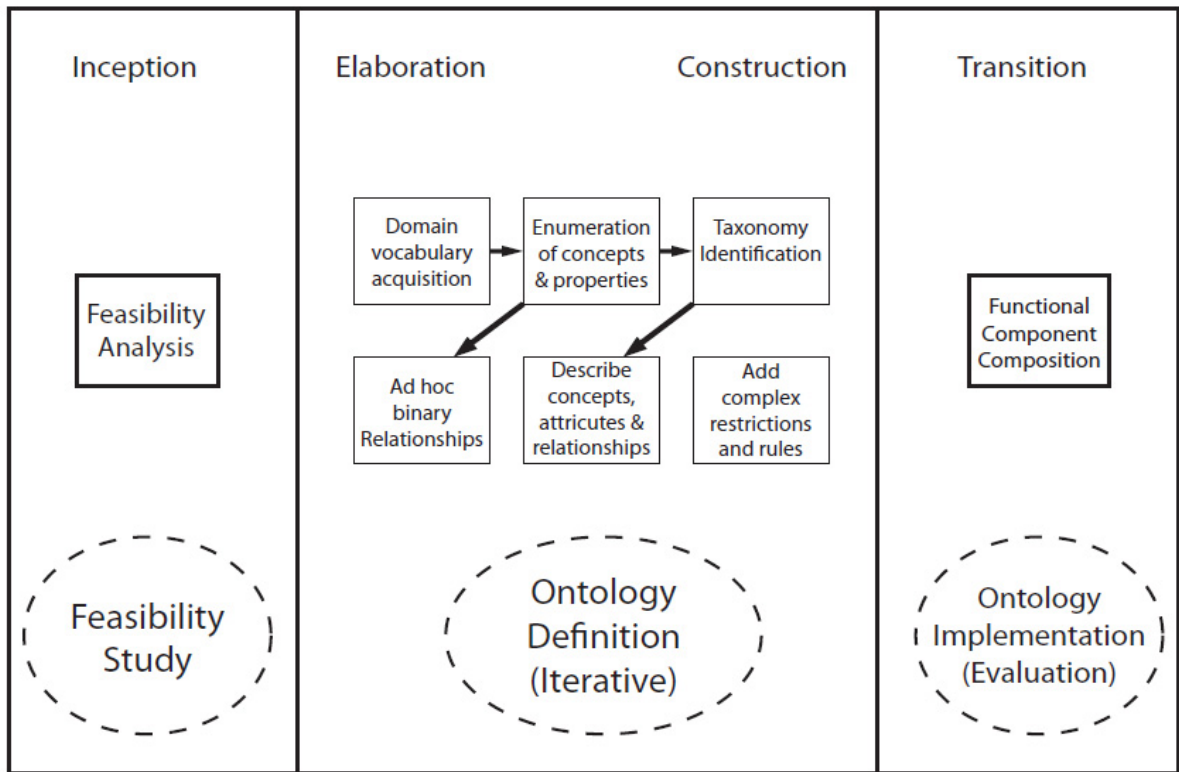


Fig 5. Hybrid Methodology followed for ontology development

**5. Conclusions and future work**

This research paper applied an innovative approach intending to introduce a new pedagogy of teaching and learning programming by developing applications for a platform instead of learning a programming language for creating applications. The proposed approach gives the opportunity for the students to develop a product in the form of mobile applications while learning their first programming course of curriculum. The proposed teaching and learning approach offers the opportunity for the students to transfer their work to personal handheld devices and then showcase to their friends and parents by making use of mobility. The proposed approach develops peer learning and paired programming approaches in the early stages of curriculum and cater them to follow agile methodologies. The proposed approach implicitly applies good software engineering principles and component based architecture from the first level programming course. The proposed approach can enhance the thoughts of entrepreneurship and

product commercialization from student life itself which can inspire their creativity beyond the conventional academic limits. The paper proposed an ontology based implementation for ensuring the consistency by following a skeletal foundation for a knowledge base. Future work will complete the total ontology development of the domain concerned and will integrate with E-learning system (Moodle). The integration will be experimented in Middle East College for evaluating the viability of developed ontology.

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