A DELPHI-BASED CONSENSUS FRAMEWORK FOR ICT INTEGRATION IN BASIC EDUCATION AND AN IMPLEMENTATION MODEL

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Abstract

This paper presents a Delphi-based consensus framework for ICT integration in basic education in the Philippines and an implementation model. In the first part, 18 experts from academe, industry, and government sectors anonymously completed the Delphi process. A consensus emerged at Round 2 of Delphi I with Average Measure Intra-class Correlation Coefficients (ICC) = 0.7 and at Round 2 of Delphi II with ICC = 0.8. As an implementation model in the second part, the framework was pilot tested in a high school which scored 54.68%. Concrete development pathways were crafted specific to the school. It is recommended that a national survey is conducted using the framework.

Introduction

As the global society emerges from industry-based to knowledge-based economy, countries have gradually recognized the importance of preparing their citizens with the necessary competencies to become qualified and able knowledge workers (Houghton & Sheehan, 2000). This new economic model puts more emphasis on the importance of new knowledge, innovation, and the development of human capacity as the sources of sustainable economic growth (UNESCO, 2008). In view of that, UNESCO has recognized that effective Information and Communication Technologies (ICT) integration starting in the basic education level is needed not only to sharpen the individuals' ICT skills and literacy but more importantly to prepare them for life-long learning based on knowledge building and knowledge sharing.

In response to that, many government efforts and private initiatives tried to address ICT integration in the school level by carving out policies and strategies, providing computers and Internet access, giving training to teachers, or by adopting an ICT-based curriculum (DepEd, 2008; Espinosa & Caro, 2010). However, it appears that ICT integration is still a challenge that remains to be addressed (Bingimlas, 2009; Trocano, 2005). This study proposes an ICT integration framework that uses the UNESCO performance indicators (UNESCO, 2003) of the impact of ICT use in education. The framework will be used to

evaluate and assist ICT integration in schools. Likewise, this study presents an implementation model that will serve as guide in carrying out a national ICT integration survey while carving individual development pathways unique for each school.

Existing ICT Integration Frameworks

One existing framework for measuring ICT integration is the CEO STaR Chart (CEO Forum, 2001). It identifies and defines four school profiles ranging from the school with "Early Technology" to the "Target Technology" school that fully integrates technology throughout the curriculum as determined by percentage ranges and other specific requirements. It has four main indicators: hardware and connectivity, professional development, digital content, and student achievement and assessment. However, this framework lacks a thorough objective process of determining a school's stage of ICT integration.

Another framework is the UNESCO performance indicators (UNESCO, 2003), which has five main indicators: ICT policy and strategy; ICT Infrastructure and access; ICT-based curriculum; teaching professionals use and teaching; student use and learning — and a comprehensive list of sub-indicators; however, it did not define stages of ICT integration. What this framework has that the CEO STaR Chart lacks is the carefully designed set of questions addressed to different respondents which enable it to gather sufficient data and to produce consolidated information on the level of ICT use in the school.

Still another more recent framework is the UNESCO ICT competency standards for teachers (ICT-CST) (UNESCO, 2008). It contains six main indicators: policy and vision, pedagogy, ICT, organization and administration, teacher professional development, curriculum, and assessment; and three stages: technology literacy, knowledge deepening, and knowledge creation. Furthermore, this framework suggests development pathways that a school can take given its current and planned efforts of ICT integration.

In this study, we make use of the UNESCO performance indicators and identify three stages of ICT integration, adopted from (UNESCO, 2008), which are: ICT Literacy-Driven, ICT Knowledge Application-Driven, and ICT Knowledge Creation-Driven. Table 1 shows the list and number of sub-indicators and questions per indicator as used in this study. We use the Delphi technique to determine the specific requirements for each indicator at each stage of ICT integration as well as to indicate the relative importance of indicators to one another in terms of percentage values or absolute values. The next section discusses the Delphi technique employed in this study.

Table 1: Number of Sub-indicators and Questions per Main Indicator used in this Study

Main Indicator	I	II	III	IV	V
Number of Sub-indicators	3	3	3	6	5
Number of Questions/Measures	8	15	3	7	5

The Delphi-based Framework

The Delphi technique is a "method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone & Turoff, 2002). According to these authors, it is a method used widely in situations when accurate information is unavailable or expensive to obtain, or evaluation models require subjective inputs to the point where they become the dominating parameters.

In this study we implement a real-time and web-based Delphi. This saves time and enables immediate interaction among the experts. The Delphi web application provided three main functions: account security through the use of passwords, comment system for the participants to support their answers in each round with an explanation, and visualization as the controlled feedback to the participants.

As regards the consensus requirement, this study uses Intra-class Correlation Coefficients (ICC) particularly the two-way random average class measures ICC (2, k) together with the other statistical measures: mean, median, and standard deviation. We adopt the formulation of ICC (2, k) from (Fleiss & Shrout, 1979):

$$ICC(2,k) = \frac{BMS - EMS}{BMS + \frac{(JMS - EMS)}{n}} \quad (1)$$

Here, *n* targets are rated by *k* judges, *BMS* refers to between-targets mean square, *EMS* refers to error mean square, and *JMS* refers to judges' mean square.

In this study, we used 0.7 as the consensus threshold. Intra-class correlation literature (Colton & Hatcher, 2004; Okoli & Pawlowski, 2004) suggests thresholds based on the need of the research. Most are in the range of 0.7 to 0.9.

The Delphi Process

Since education is a joint effort of three major stakeholders — academe, government, and industry — we invited experts from each of these sectors. It is also important that each sector will have a balanced representation in the final

expert panel. We asked 26 identified experts in all sectors. Of the 26 identified experts, 18 of them were able to make it on the actual Delphi study. Of this final list, 5 come from the academe, 6 come from the industry, and 7 from the government sector. This size of the Delphi panel is enough to come up with reliable results (Okoli & Pawlowski, 2004).

This study makes use of two Delphi sub-studies to come up with a detailed framework. The objective of the first Delphi sub-study (Delphi I) is to distribute 100% to the five main indicators. The percentage given to each indicator reflects its relative importance in the whole framework according to each expert. The answers of all experts were averaged to get the final percentage for each indicator after the group has come to a consensus. The objective of the second Delphi sub-study (Delphi II) is to identify the relative importance of sub-indicators in each stage of ICT integration. The experts rate the importance of the sub-indicator, indicate the percentage, or select the appropriate threshold requirement at each stage.

Delphi I consisted of three rounds while Delphi II consisted of only two rounds. On the first round, the participants were presented with the indicators or sub-indicators which they were to rate. For Delphi I, they can put their comments on why they choose that certain percentage distribution among the indicators. On the second and third rounds, the following elements were shown to the participant: his/her previous answer, the group answer (average), and anonymous comments from the experts (in the case of Delphi I). For the Delphi I, other data visualizations were also shown in order to aid their decision such as percentage distribution among sectors, box plots to show distribution of individual answers, and juxtaposed group and the expert's answer.

Analysis of Results

This section discusses the results of the two Delphi sub-studies forming the one ICT integration framework with differences only in the level of detail. Table 2 shows the statistical summary over three rounds in Delphi I.

Table 2: Statistical Measures of Delphi I in Three Rounds

	Mean					Median					STDEV				
Round	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
1	18	24	18	21	19	20	25	20	20	20	6.99	5.46	5.66	6.13	5.06
2	19	24	18	20	19	20	25	20	20	20	6.51	5.33	4.93	5.35	4.42
3	20	24	18	19	19	20	25	20	20	20	6.11	5.06	4.83	4.77	4.66

The standard deviation of Round 2 shows that the experts vary in their answers mostly in the first indicator: ICT-based policy and strategy; while they vary least with one another on the last indicator: student learning and outcomes. It is also

noticeable from Table 2 that the median values stayed the same for all indicators in all rounds.

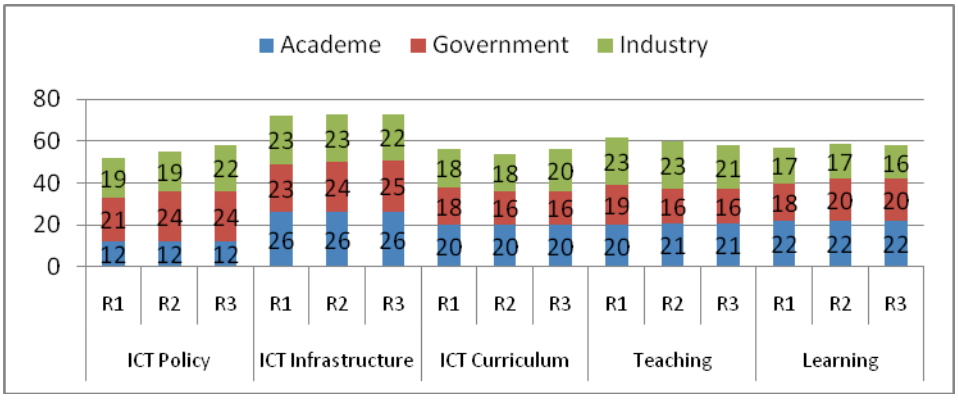
The vote percentage distribution among subgroups (see Figure 1) can be explained through their comments. The academe subgroup consistently sees ICT infrastructure as the primary mover in the ICT integration process while the student learning, teacher competency, and curriculum follow in order. One of the comments that support this is: "ICT infrastructure and access gets the highest share because it will facilitate the extent to which the teachers can explore and be abreast of the current trends in IT and the development of the skills of the users." Their low rating given to ICT policy can be attributed to the perceived lower importance relative to the other indicators.

The government subgroup puts ICT policy and the ICT infrastructure above the other indicators as the following comments indicate:

> Before any initiative can come into fruition, there is a need to institutionalize policies in order for other indicators to progress [. . .]. Without these, other initiatives could be futile. Once policies are in place, provision of infrastructure and ensuring that the curriculum involves ICT, teacher and student use can come to place.
>
> ***
>
> I believe that a strong initiative of the govt to create such ICT policy must be done first and all else shall follow. The policy should give importance on the infrastructure. Without a credible connectivity, an effective curriculum, teaching and learning may not materialize.

The industry subgroup places emphasis on the concerted effort among stakeholders. It recognizes the importance of the ICT infrastructure and teacher competency over others. One comment said that bigger emphasis should be focused on the mentioned two because they form the building blocks for the other indicators (e.g., student learning hinges on teacher competency and ICT infrastructure).

Figure 1: Subgroup Percentage Ratings from Round 1 to 3 of Delphi I



In the three rounds of Delphi I, Round 2 has the highest ICC value of 0.7, which lies in the threshold boundary, meaning it is the round where the consensus emerged among the participants.

In the two rounds of Delphi II, the consensus emerged in Round 2 with ICC = 0.8, while in Round 1 the ICC value only reached 0.4. The outliers were handled accordingly. Following the logic of increasing sophistication across the stages, answers with the inverted pattern were replaced with the value in the highest stage. If the percentage of teachers with pre-service training is expected to increase from stage 1 to stage 3, then if answers were instead going down from 40% , 30%, 20% from stage 1 to stage 3, respectively, then the stage 1 and 2 answers were replaced with 20%. This may have resulted from an unguided criterion. Nevertheless, with this method of handling outliers we have preserved the intention of the experts.

Construction of the Framework

As mentioned above, this study modified the three approaches of UNESCO ICT-CST document to fit the ICT integration stages. Each stage per question or measure is defined by a lower and upper limit requirement which translates to a range of values. These values were the consensus values arrived in Delphi II. A school is said to be in a particular stage of ICT integration only on a direct relation to the individual measure concerned and indirectly to the sub-indicators and indicators. This is explained more in the next sections. This framework also defines the stage prior to stage 1 as the "ICT Ad Hoc Stage" of ICT integration where the efforts on ICT integration still falls below the stage 1 requirement.

The ICT integration score refers to the overall score the school obtains after the questionnaires are filled out by a certain number of each type of respondent. A detailed matrix of scores is computed using the answers provided by each of the respondents. It shows the score per question which is cascaded to the sub-indicator and finally to the indicators. The structure of the computation is similar to the Global Competitiveness Index (GCI) (Klaus Schwab, 2010) except that the indicators, sub-indicators, and questions assumed different percentage values.

Implementation Model: A Case Study

This section presents how the framework is used to evaluate the ICT integration of a school and it discusses how to implement a development pathway intended to gear up from the current stage of ICT integration of the school to the next. We have chosen a private high school in Laoag City, Ilocos Norte, Philippines for this case study.

Due to time and resources constraints we conducted a stratified random sampling among the teachers and students. The respondents were: the head of school, 10 teachers (5 from first year and 5 from fourth year), and 20 students (10 from first

year and 10 from fourth year). Since the first and fourth years represent the entry and exit years in high school, it could provide a glimpse of all the year levels. The survey was conducted online while supervised by the researcher.

Findings

Table 3 shows the actual scores of the school against the ideal percentage scores in each indicator. If there were no space constraints, the "Display Level" can actually be collapsed up to three levels (i.e., sub-indicators, questions, and sub-questions) each of them showing in a form of a matrix their respective scores. The 3rd to the 8th column in Table 3 would show the actual value and the corresponding scores based on the framework depending on who are the respondents involved in the survey for that specific question/sub-question.

Table 3: The Ideal vs. the Actual ICT Integration Scores

Display Level: 1 2 3

Indicator	%	HV	HS	TV	TS	SV	SS	Total
ICT Policy and Strategy	19							18.09
ICT Infrastructure and Access	24							14.04
ICT-Based Curriculum	18							14.44
ICT Teaching Competency	20							2.97
Learning Processes and Outcomes	19							5.15
							Total	54.68

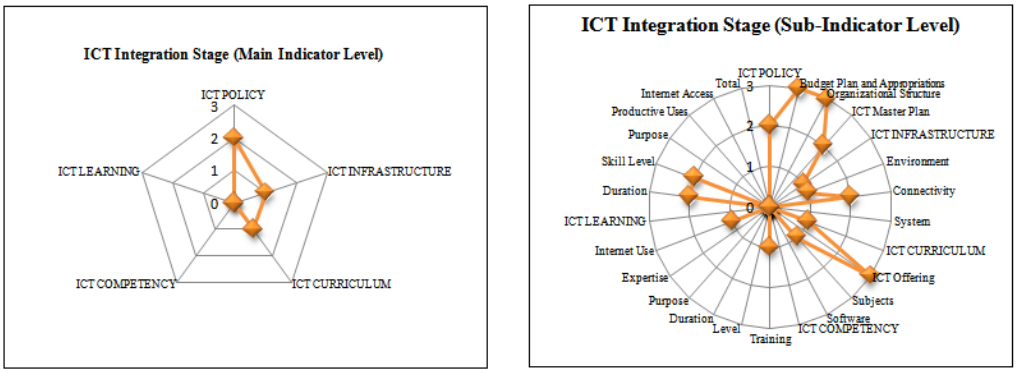
The ICT integration score is 54.68% of the ideal level. The lowest scoring indicator is teaching competency. Out of 18 teachers, only 3 of them had pre-service ICT training and only 4 attended in-service ICT training. Of the teachers who had trainings, most of the trainings are basic level (i.e., use of spreadsheets, word processing, and presentation tools) and the average training duration per teacher is only 5 hours. The use of the Internet for teaching is limited to a few times a month to at most twice a week. Further personal development is still in the Ad Hoc stage which explains the zero percentage of teachers who use ICT in the classroom.

The highest scoring indicator is ICT policy and strategy. This covers only three major sub-indicators. Under the "Budget Plan and Appropriations" sub-indicator, it registers the highest possible budget allocation of 10%. This is expected because they have a formally established ICT office which is shared by the university and most of the time they have followed their ICT Master Plan when implementing ICT projects. However, the ICT infrastructure falls even below half the ideal. When examined deeper, the computer to student ratio is still in the Ad Hoc stage as well as the bandwidth requirement for every 1000 students. The average age of computers falls also very low at 8 years. In majority of the ICT

facilities, there is an inverted availability and accessibility pattern. The principal perceives the highest accessibility and availability of ICT facilities, followed by teachers and lowest by students who are the direct and the bulk of the users of these facilities.

Under ICT curriculum indicator, it is observed that in addition to having a separate ICT subject, the respondents also perceived a higher usage of ICT in other subjects such as science, English and mathematics except that usage of educational software in classes is still in the Ad Hoc stage. Under learning processes which measures the students' engagement in the use of ICT in learning, their level of skills in ICT applications ranges from basic to intermediate capability. However, the frequency and level of ICT use for their schoolwork is still in the Ad Hoc stage. This can be explained by the lack of expertise of teachers in integrating ICT into their classrooms as cited above. Their low score under productive uses of computers also reflects this fact which is also compounded by their low percentage in access to Internet and its frequency. Figure 2 shows a visual representation of the ICTiIntegration stages in the main indicator and the sub-indicator levels.

Figure 2: ICT Integration Stages in the (a) Main Indicator Level and the (b) Sub-Indicator Level



Development Path

Based on Figure 2a, the school is in Stage 2 of ICT integration with respect to ICT policy; Stage 1 with respect to ICT infrastructure and ICT curriculum; and Stage 0 (Ad Hoc Stage) with respect to ICT learning and ICT competency. By drilling down to the sub-indicator level (Figure 2b) we concretely suggest its own development path. Particularly, the school has to work more on giving ICT training to teachers from literacy to application and integration in their classes. For instance, they can find ways to increase the in-service trainings as well as the level and duration of those trainings. The school can also devise ways to give incentives to teachers who demonstrate innovative ways in integrating ICT in their classes. Aside from training for teachers, the school can also purchase more

educational software that can be used by teachers in their classes. On the infrastructure level, the school can work on increasing the computer to student ratio in the most cost-effective means possible. They can also increase their bandwidth subscription to be able to access multimedia materials that can be used by students and teachers in their classes. All these efforts should be guided and championed by the head of the school to take it to effect for without it nothing much could be achieved (Espinosa & Caro, 2010).

Conclusions and Recommendations

This study has presented a Delphi-based consensus framework for ICT integration in basic education. The experts reached a consensus for the whole ICT integration framework with ICC = 0.7 in Round 2 of Delphi I and ICC = 0.8 in Round 2 of Delphi II, respectively. As an implementation model, a pilot survey was conducted to test the framework and the development path was crafted specific for the pilot school. A national survey is proposed to be conducted using the framework. This can be used to evaluate and guide the ICT integration of each school, district, and division.

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