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Communicative Computing Literacy Curriculum Design for Senior High School Students: Bridging Electronics Engineering (ICT) and Community Development

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Highlights

- Curriculum design of a technical-vocational track that is leading to an engineering academic track with strong emphasis on Community Development
- Prince Modelling of the Political Feasibility of Designed Curriculum
- Sensitivity Analysis of the Stakeholders for a deeper insight of the possibility of future adoption in schools

Abstract

This papers developed a curriculum for Senior High School students that would serve as a preparation for an eventual career in Electronics Engineering, particularly in its Information and Communication Technology field of specialization while at the same time, prepare them to help alleviate poverty in poor communities immediately after graduation. Using the Stuffle Beam's Model of Curriculum Development, paper tackled two main problems: (1) What courses are necessary to be taken by the students to help the community acquire communicative computing literacy while preparing themselves for a career in Electronics Engineering; and (2) What emerging technologies should be integrated in the curriculum in order to meet the needs of both the community developers and communities they strive to develop? In the process of curriculum design, relevant courses were identified and sequenced in order to produce the desired output. Context, Input, Process and Product were also tackled in accordance with this model. Special attention was devoted on the product to analyze not only the technical aspect of the curriculum but also its political aspect using Stakeholder Analysis and the Prince Method. The probability of support of the stakeholders was also computed in order to determine how strong this proposed curriculum would stand to policymakers. Finally, sensitivity analysis was done in order to study the effect of the position of the different stakeholders on the position, power, and salience ratings. The computed Prince Rating for this curriculum is 64.3%. It was also determined that the probability of support is least sensitive on the residents and students but most sensitive to the position of the school administrators and teachers. It is generally insensitive to position and salience.

Key Words: Senior High School; Technical-Vocational-Livelihood (TVL); Science, Technology, Engineering and Mathematics(STEM); Electronics Engineering Education; Curriculum Design

1. Introduction

Today's technology has continued to help improve the lives of those who have access to it, particularly the rich. A simple flooding, for instance, does not just destroy their homes but also exposes the poor to diseases such as leptospirosis which claims the lives of many. That is why there is a need for men and women who have the desire to help their underprivileged countrymen lift themselves up from poverty through the use of technology. According to ADB (ADB, 2013), there is 26.5 million poor people in the Philippines alone. There is plenty of work to be done and a high demand for people who would dedicate their lives in the service of others. While many have the heart, not many are equipped to do this service. There are even

some who have caused more harm than good in their effort to help (Corbett et. al, 2012). That is why it is necessary to create a curriculum that produces men and women who do not only have the heart to serve but also the technological know-how to equip the underprivileged with the technological skills necessary to free themselves from the bondages of poverty.

2. Objectives

This paper aims to design a curriculum that will not only prepare Senior High School students under DepEd's K-12 program for an eventual career in Electronics Engineering but will also train them to build communicative computing literacy in poor communities immediately upon graduation. In particular, this paper seeks to determine the answer to the following questions:

1. What courses are necessary to be taken by the students to help the community acquire communicative computing literacy while preparing themselves for a career in Electronics Engineering?
2. What emerging technologies should be integrated in the curriculum in order to meet the needs of both the community developers and communities they strive to develop?

3. Scope

3.1 Students

The curriculum to be developed is intended to be offered to Junior High School finishers as a technical vocational course under the existing curriculum.

3.2 Courses

Table 1 and 2 shows the outcome of the curriculum developed for Grades 11 and 12 respectively. The include preparatory courses for ECE or ICT-related program have been marked with an asterisk (*). The process by which this was developed is discussed in Section 4.

Table 1. Grade 11 Courses.

Course Code	Course Title	Pre-requisite	No. of Lecture Hours Per Week	No. of Lab Hours Per Week	Total No. of Hours Per Week	Credit
ICT 11-A	Computer Fundamentals and Concepts*	Grade 11 Standing	1	2	3	1
ICT 11-B	Open Source Applications for Business	Grade 11 Standing	1	2	3	1
ICT 11-C	Logic Circuits*	Grade 11 Standing	1	2	3	1
ICT 11-D	Data Structure and Algorithms*	Grade 11 Standing	3	0	3	1
Math 11	Pre-calculus and Discrete Mathematics*	Math 10	3	0	3	1
Educ 11	Foundations of Education	Grade 11 Standing	3	0	3	1
CD 11	Introduction to Community Development	Soc Sci 10	3	0	3	1
English 11	Speech Communication	English 10	3	0	3	1
Soc Sci 11-A	Philosophy	Soc Sci 10	3	0	3	1
Soc Sci 11-B	Development Perspectives and Social Movements	Soc Sci 10	3	0	3	1
TOTAL			24	6	30	10

Table 2. Grade 12 Courses.

Course Code	Course Title	Pre-requisite	No. of Lecture Hours Per Week	No. of Lab Hours Per Week	Total No. of Hours Per Week	Credit
ICT 12-A	Software Engineering*	Grade 12 Standing	1	2	3	1
ICT 12-B	Data Communication and Networking*	ICT 11-D	1	2	3	1
ICT 12-C	Logic Design and Switching Theory*	ICT 11-C	3	0	3	1
ICT 12-D	Programming Languages and Compiler Design*	ICT 11-A / ICT 11-C	1	2	3	1
ICT 12-E	Operating System and Assembly Language*	ICT 11-A	1	2	3	1
Educ 12	Non-formal Education	Educ 11	3	0	3	1
CD 12-A	Communication and Innovative Strategies for Community Development	CD 11	3	0	3	1
CD 12-B	Peoples Initiatives, Social Enterprises and Community Organizing	CD 11	2	4	6	2
Soc Sci 12	Professional Ethics	Grade 12 Standing	3	0	0	1
TOTAL			18	12	30	10

3.3 Model

This paper uses Stufflebeam's Model of Curriculum Development as presented by Stufflebeam and Shinkfield [3]. (See Figure 1.) This model contains four elements: context, input, process, and product. These elements are used in order the production of a curriculum. In the context of this research, the details are found in Section 4.

4. Curriculum Development

4.1 Context

In the article published by the Philippine Daily Inquirer [4], it is reported that there is an estimated 10.4 million Filipinos who consider themselves to be poor. The paper also quoted National Statistical Coordination Board (NSCB) report that the poverty incidence in the Philippines at 27.9% in the first half of 2013 is statistically equal to 28.8% and 28.6% in 2006 and 2009 respectively. While poverty is a multi-faceted issue as described in the thesis of Bas [5], Lavizzo-Mourey [6] asserts that Community Development and Poverty are inseparable. She even went so far as to say that "a child's life expectancy is predicted more by his ZIP code than his genetic code."

Figure 1. Stufflebeam's CIPP

In order to alleviate poverty, one of the tools that community developers can use is equipping the poor with communicative computing literacy so that they can cope up with the introduction of new technologies. In the research done by Quibria and Tschang [7] entitled "Information and Communication Technology and Poverty: An Asian Perspective", they found out that "as far as direct impacts are concerned, the use of Information and Communication Technologies (ICTs) holds significant promise." That is why a course which will help future community developers help the poor by helping the underprivileged acquire communicative computing literacy is in order. In order to produce such breed of community developers, this program will be integrated in the current K-12 curriculum under the Technical-Vocational-Livelihood tract.

A salient feature of the SHS curriculum is immersion as specified in the Official Gazette [8]: Students undergo immersion, which may include earn-while-you-learn opportunities, to provide them relevant exposure and actual experience in their chosen track.

At the end of the SHS, it is the objective of the K-12 curriculum to produce a holistically developed Filipino who is ready for "further education, employment, or entrepreneurship." The K-12 curriculum further provides that every graduate will be equipped with the following:

- Information, media and technology skills
- Learning and innovation skills
- Effective communication skills
- Life and career skills

Hence, these points are necessary for the Communicative Computing Literacy for Community Development program. Formally, the goal and objectives of this program are as follows:

4.1.1 Goal

The goal of this program is to produce Senior High School graduates who will serve fellow Filipinos as community developers specializing in Information and Communication Technology who would help the underprivileged acquire communicative computing literacy. Eventually, they may also pursue a degree in Electronics Engineering as their training also contains introductory courses towards such degree.

4.1.2 Objectives

In general, the objectives of the program are as follows:

1. To inspire students throughout their Senior High School years to empower the underprivileged to help themselves by equipping the poor with communicative computing skills through community development.
2. To expose the students with emerging technologies which have potential use in Social Enterprising.
3. To equip students with the skills necessary to acquire NC II in PC Operation and NC II in Hardware Operation upon graduation.
4. To prepare students for an eventual degree in Electronics Engineering.

4.2 Input

Faculty specializing in technology is a vital input in the curriculum. However, even good teachers are not enough if there aren't enough facilities at any given public school in the Philippines. That is why the Department of Education allows partnership with Colleges and Universities for high schools which would be unable to provide facilities like basic classroom for Senior High School. At the right price (which can also be in the form of recognition of the host institution's social responsibility), Grades 11 and Grade 12 may be able to avail of network laboratories and state of the art classrooms. College faculty may also be hired as part-time high school teachers to augment the needed manpower of the current high schools.

An alternative strategy that may be taken is to provide for practicum alternative in the curriculum. For instance, instead of taking the regular laboratory class of ICT 12-B (Data Communication and Networking), students may be given the option to take a practicum in an accredited company so that they may learn industry application of Data Communication and Networking. The lecture component, on the other hand, may just be given on Saturdays so that Senior High School students may be able to use the school facilities which would otherwise be unavailable on weekdays. For instance, jobstreet.com offers 395 jobs for students. Schools that would offer this program may explore creating a memorandum of agreement (MOA) with several of these schools to cater to the needs of the program namely, facilities and opportunities to solve data communication and networking problem hands on. Another option would be to partner with Colleges offering Senior High School Immersion program in ICT. (An example of such college would be the school where the authors are currently affiliated to.) This would allow the students to use the college's data communication and networking facilities and do actual hands on training. Table 3 shows a sample Grade 11 schedule employing the practicum alternative to laboratory.

It can be seen in Table 3 that such schedules would not necessitate building additional classrooms and other facilities since the schedule of classes would be outside the normal school hours of regular high school students.

Table 3. Sample Alternative Class Schedule of Grade 12 Students.

Course Code	Course Title	MON	TUE	WED	THU	FRI	SAT
ICT 12-A	Software Engineering	10 to 30 Hours of Practicum in an ICT Company					7-8 AM
ICT 12-B	Data Communication and Networking						8-9 AM
ICT 12-C	Logic Design and Switching Theory						9 AM - 12 NN
ICT 12-D	Programming Languages and Compiler Design						1-2 PM
ICT 12-E	Operating System and Assembly Language						2-3 PM
Educ 12	Non-formal Education			6-7:30 PM		6-7:30 PM	
CD 12-A	Communication and Innovative Strategies for Community Development		6-7:30 PM		6-7:30 PM		
CD 12-B	Peoples Initiatives, Social Enterprises and Community Organizing	4 to 8 Hours of Practicum in an Non-government Organization					3-5 PM
Soc Sci 12	Professional Ethics	6-7:30 PM					5-6:30 PM

The schedule in Table 3 would also allow hiring college instructors as professors since most of the major lecture classes are held only on a weekend.

The 10-hour practicum for ICT 12 (A to E) may be done in just one company, provided such company can impart skills on the competencies being built by these courses. The school may also increase the number of practicum hours to 30-hours for these major courses if the school and the partner company so desire since the students have a number of vacant hours during weekdays. CD 12-B, on the other hand, should be field

immersion in a non-government organization (NGO) specializing in helping the poor. This should be mandatory for both mainstream and alternative application of this curriculum as this is designed to expose students to the rigors of Community Development. The required number of hours for CD 12-B is a minimum of 4 hours per week but may be increased by the school and the partner NGO upon mutual consent to a maximum of 8 hours per week for practicum-based implementation of the curriculum and up to 20 hours for the regular implementation of the curriculum. Table 4 shows this being incorporated in class schedule. Considering the facilities and human resources that most schools have, the second alternative may be more viable.

Table 4. Sample Alternative Class Schedule of Grade 12 Students.

Course Code	Course Title	MON	TUE	WED	THU	FRI
ICT 12-A	Software Engineering	7-8 AM (lec)				7-9 AM (lab)
ICT 12-B	Data Communication and Networking	8-10 AM (lab)				9-10 AM (lec)
ICT 12-C	Logic Design and Switching Theory		7-8:30 AM (lec)		7-8:30 AM (lec)	
ICT 12-D	Programming Languages and Compiler Design			10-12 NN (lab)		10-11 AM (lec)
ICT 12-E	Operating System and Assembly Language		8:30-10 AM (lec)		8:30-10 AM (lec)	
Educ 12	Non-formal Education	10-11 AM (lec)	10-11 AM (lec)		10-11 AM (lec)	
CD 12-A	Communication and Innovative Strategies for Community Development			7-10 AM (lec)		
CD 12-B	Peoples Initiatives, Social Enterprises and Community Organizing	20 hours of Practicum in an NGO (1-6 PM)				11 AM-1 PM (lec)
Soc Sci 12	Professional Ethics	11-12 NN (lec)	11-12 NN (lec)		11-12 NN (lec)	

4.3 Process

There are several processes that may challenge the full implementation of the program. These are possible defects in the implementation process that must be paid full attention to in order for the program to be effective. The first one is with regard to providing the equipment and facilities Another process that might pose a challenge is the faculty hiring. Existing high school faculty teachers may not have the required competency to teach ICT or community development. That is why hiring instructors from college may be necessary. A third process that would be challenging is the integration of the community development program. If this is not done properly, this may do harm not only to the students but also to the residents of the community. Under the paradigm of Community Development, programs in the community must be participatory. Otherwise, it would not have the intended effect of "helping the poor help themselves." The fourth challenge would be teaching the students ICT. For schools who do not have strong ICT program in the lower grades, teaching ICT 11-A, for instance, may be a challenge since the basic computer literacy might not be even there. Finally, maintaining the computers and other ICT equipment in the laboratory would be a challenge since some public schools cannot even buy adequate number of computers. How much more could they afford to hire an IT staff to maintain the computers?

4.4 Product

The product, in the case of this paper, is the Curriculum for the Communicative computing Literacy for Community Development. One way by which this can be evaluated is through Stakeholder Analysis and the Prince Method.

4.4.1 Stakeholder Analysis

Stakeholder Analysis, according to Florano [11], is "an organized approach to understanding system, by means of identifying stakeholders and assessing their relationships and their interests in, or influence on that system." This is important because it increases the political feasibility and acceptability of a given social policy. Moreover, it is an important tool in comprehending the intricacies of "policy-making, strategic policy planning, adoption and implementation." Position of the different stakeholders are the

perception of the authors based on literature review and actual interactions. Uncertainty in these positions are addressed by the Sensitivity Analysis in Sections 4.4.3 to 4.4.5.

Using this method, the position of the different stakeholders was determined, as well as their motivations and sources of power. Then, stakeholders mapping was carried out to identify the policy champion and other players. Results of this were also used in the Prince Method.

Table 5 shows the Stakeholder Analysis of this curriculum:

4.4.2 The Prince Method

The Prince Method is by first grouping stakeholders with similar stand on an issue based on the general knowledge of the issue. In the event that a particular stakeholder is divided in its stand on the issue such as the Chief Executive and the Congress of the Philippines (which is actually a part of the National Government), then they were treated as if they were two entities. [12]

There are four steps in the Prince Method. The first one would be to discover the "actors." The actors, in this case, may be just an individual or a group of people that would probably have a direct or indirect say on the decision. Second would be to find out the "issue position" of each actor. "Issue position" (i) is an estimate of whether or not each actor would uphold, counter or be neutral towards the decision. Based on the perceived position, actors were rated from -3 to +3 where +3 connote strong support and -3 connote strong opposition while 0 connotes neutrality. Third would be to decide on the "power" (p) or how valuable each actor is in promoting or hindering the decision or its implementation. Here, a scale of +1 to +3 is used where +1 connotes weak power while +3 connote strong power. Again, power is rated based on the perception of the researcher. Finally, "salience" (s) or how essential the decision is to every actor is inferred. Salience was rated using a +1 to +3 scale where +1 connotes weak salience and +3 connotes high salience. The details of deciding on the issue position, power and salience can be found on pages 25-26 of Coplin and O'Leary. Using weights assigned for each actor, the score (x) per actor is given by (1) below:

$$x = i\ p\ s \qquad (1)$$

where:
i = issue position of the actors
p = power of the actor
s = salience

Table 5. Stakeholder Analysis.

Stakeholders	Position /Stand	Motivations/Values/ Beliefs	Sources of Power
Chief Executive	Yes	Serve the interest of the Filipino people. Fighting poverty is a priority issue of the government and the government is generally supportive of initiatives that fight poverty.	Has the authority to approve and execute laws.
Congress of the Philippines	Neutral	While the Congress may be supportive of the idea of offering a course that would help fight poverty by providing technology, it may be hesitant to approve an increase in the budget of the Department of Education to be able to buy the facilities needed to offer such course.	Has the power to make laws, including the General Appropriations Act.
Department of Education	Yes	The proposed curriculum is an enhancement of the Senior High School program of the new K-12 curriculum. The curriculum would adhere to DepEd's goals for the K-12 curriculum. Hence, there is no reason for DepEd to reject the proposal.	Has the power to implement the K-12 curriculum
Local Government (with NGOs and Concerned ICT Companies)	Yes	The local government would be supportive of such program since it would serve the community where it is situated.	Has the powers to implement the law.
Local Residents	Neutral	Because of the number of courses offered by numerous schools, local government could not care less about another program being offered.	Has the power to vote for local and national government officials.
School Administrators	No	Most schools may not be ready to have such program for Grade 11 and 12 because of the demand of the program in terms of technology and manpower.	Has the power to implement policies.
Teachers	No	Except for a few, teachers might find themselves incompetent to teach community development or Information and Communication Technology. Considering the work load that they already have, training to teach these subjects may not be received with much applause.	Has the power to implement programs in the classroom.
Students	Neutral	The proposed curriculum may be perceived just one among the many courses that may be offered by the school. Hence, it would not draw much attention.	Has power to enroll in such program.

The probability of adapting the proposed curriculum (P) was computed by using (2),

$$P = \frac{(A + 0.5\,C)}{(A+B+C)} \quad (2)$$

where:
A = computed score of all actors supporting the issue
B = absolute value of all actors opposing the issue
C = computed scores of actors with neutral issue positions

Both Equations 1 and 2 were developed by Coplin. Accordingly, if P < 0.6, the proposed curriculum has a low feasibility of being implemented and hence, interventions are needed.

Table 6. Prince Chart.

Stakeholders	Issue Position (-3 to +3)	x	Power (1 to 3)	x	Salience (1 to 3)	=	Prince Scores
Chief Executive	3		3		1		9
Congress of the Philippines	0		2		1		(2)
Department of Education	3		2		1		6
Local Government (with NGOs and Concerned ICT Companies)	1		1		1		1
Local Residents	0		1		1		(1)
School Administrators	-1		2		2		-4
Teachers	-1		2		2		-4
Students	0		1		1		(1)
Calculation 1: A + 0.5 C Sum of all the positive scores plus ½ neutral scores)							**18**
Calculation 2: A + B + C Sum of all scores ignoring signs and parenthesis)							**28**
Probability of Support, $P = (A + 0.5C)(A+B+C)^{-1}$ (Calculation 1 divided by Calculation 2)							**64.3%**

Following the steps described, each entry was entered based on the perception of the authors. For instance, the Chief Executive were given +3 in the position since the President is generally viewed to be pro-poor and would greatly support such initiative. His power is 3 as well since he is the most powerful among the stakeholders in terms of affecting the outcome of this initiative if it is proposed. Salience is rated as +1 because there are other more important things for the President such as the war on drugs. The same method of intuition was done to the other stakeholders.

4.4.3 Sensitivity Analysis to Position Ratings

To study the effect of the position of the different stakeholders on the probability of support, a sensitivity analysis on the effect of the issue position on the political feasibility of the proposed curriculum was done as shown in Figure 2. The broken line (----------) shows the 60% mark while the dotted line (·····) shows the computed probability of support. The vertical axis represents the probability of adoption of the proposed curriculum while the horizontal axis represents the different possible positions of the different stakeholders. Note that for the sake of shortening the labels, the Local Government (with NGOs and Concerned ICT Companies) have been labelled as "Local Gov't."

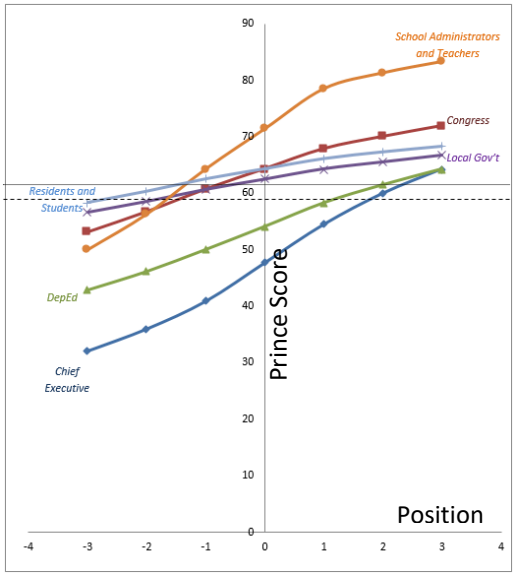

Figure 2. Sensitivity Analysis of Position using Prince Method.

The position on the horizontal axis when the probability functions of the different stakeholders cross the dotted line represent their current stand on the issue. Once the broken line is crossed, it means that the proposed curriculum can be possibly adapted at its corresponding stance on the horizontal axis. The inverse of the distance in the horizontal axis corresponding to when the dotted line and the broken line are crossed represent the sensitivity of the probability to changes in the stand of a particular stakeholder to the issue.

Based on the graph, the probability of support is least sensitive on the residents and students as it their position can still go down by two scores and yet the curriculum would still be adopted. It is most sensitive, however, to the position of the school administrators and teachers because just a level lower than their current stand on the position would render the entire curriculum not feasible.

4.4.4 Sensitivity Analysis to Power Ratings

For the purpose of this discussion, the sensitivity to power ratings is unnecessary since it is highly unlikely that the power of the different stakeholders would change in the near future. For instance, under the present Constitution, the Chief Executive is still more powerful than the Legislative while the Local Government is still more powerful than the local residents when it comes to affecting change in the curriculum. In the same way, School Administrators and Teachers would have more power over the implementation of the curriculum than the students. Hence, since the movement in the power ratings is unlikely, sensitivity analysis becomes unnecessary too.

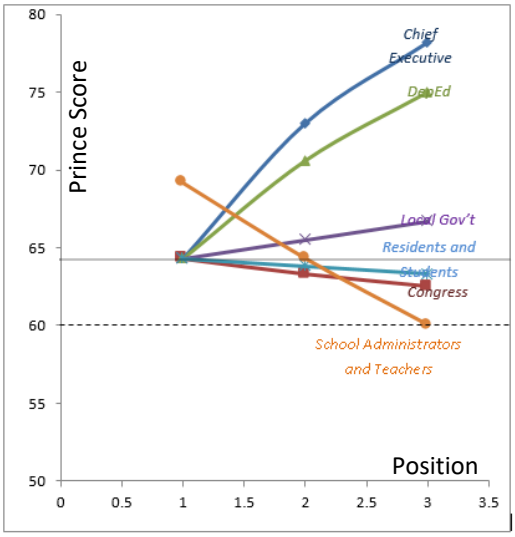

Figure 3. Sensitivity Analysis of Salience

4.4.5 Sensitivity Analysis to Salience Ratings

Salience refers to how is the perceived importance of a particular issue is to the different stakeholders. Because of salience can change as with position, sensitivity analysis is essential in order to understand its effect on the probability of support. This data is presented in Figure 3.

Just like in the section on the sensitivity of position, the broken line shows the 60% mark while the dotted line shows the computed probability of support. The vertical axis represents the probability of adoption of the proposed curriculum while the horizontal axis represents the different possible salience of the different stakeholders. The positions on the horizontal axis when the probability functions of the different stakeholders cross the dotted line represent their current salience on the issue. Once the broken line is crossed, it means that the proposed curriculum can be possibly adapted at its corresponding stance on the horizontal axis. The inverse of the distance in the horizontal axis corresponding to when the dotted line and the broken line are crossed represent the sensitivity of the probability to changes in the salience of a particular stakeholder to the issue. Based on the graph, the probability of support is insensitive to salience as the viewed importance on the proposed curriculum may drop to the extreme values and yet, the computed probability of support would still be at least 60%. It should be noted, however, that increasing interest on the curriculum on the part of the teachers and school administrators, residents and students, and the Congress, result in decreasing probability of support, albeit p is still within acceptable level. This drop is mainly due to their neutral or negative positions toward the curriculum. Since their interest has now increased, the overall effect of the neutrality or negativity of their positions caused the overall prince score to drop.

5. Conclusion

This paper was able to propose a curriculum of senior high school students that would empower them to help poor communities while preparing them for pursue a career in ICT, a field of Electronics Engineering, in the future. The probability of adoption of the proposed curriculum is acceptable at 64.3% Prince Rating. Sensitivity analysis was done to tackle uncertainty.

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