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From Digital to Manual Conversion Between Number Systems: An ASSURE Learning Design

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Abstract
Technology integration in educational setting has gained wide acceptance and practice since it makes easy and quickens students' learning. However, developing students' number systems conversion skill without proper resources calls for teacher's intervention. This educational action research put into operation the ASSURE Model to develop students' competence in converting numerical data between each number system. Participants included all of the twenty four 9th Graders taking Creative Technologies under the Special Science Program at Laoang National High School. Data collection involved survey questionnaires, focus group discussion, unstructured interviews, documents, participant observation, and teacher-made test which underwent proper validation. Descriptive statistics, thematic analysis, and document analysis were employed. Learners analysis revealed that the participants were female dominated, at regular age, indigents, lived outside town proper, owned gadget, used free data for internet access, learned better with sounds and tangible learning materials, and strongly driven to finish activities when given task. Findings showed increasing number of learners who achieved outstanding scores in the series of conversion tests given as manifested in answer sheets and field notes. To further corroborate these results, participants articulated that the learning design used made manual conversion between number systems easy and quick, guided in-depth analysis of conversion process, and encouraged knowledge sharing among themselves. Regulated and proper use of smartphones and internet access in teaching and learning processes was highly recommended.
Keywords: ASSURE Model, learning styles, motivational factors, action research, number systems conversion

1. Introduction

The Department of Education has been intensifying (Dar, 2017) the integration of Information, Communication and Technology in teaching and learning process (Department of Education, 2010) as students' lives become interwoven into the fabrics of technological advancements easily revolving their learning interests and motivations away from textbooks and other printed materials. This created a negative ripple effect on the way teachers design class instructions as engaging students becomes more and more challenging which necessitates innovative instructional technology. Thus, the researcher committed himself into using the 6-step ASSURE Model in planning and conducting instruction that incorporates media and technology (Heinich, Molenda, & Russell, 1993) particularly Number Systems Converter ("Number Systems - Online Digital Electronics Course," n.d.) to steer students' ability to convert between number systems manually. This model involves the following steps; (1) Analyze learners, (2) State objectives, (3) Select methods, media and materials, (4) Utilize media and materials, (5) Require learner participation; and (6) Evaluate and revise. Anchored on constructivist perspective (Gagné, Briggs, & Wager, 1992), it is the most convenient model (Megaw, 2006) in integrating instructional technology as it requires less complex media, few hours of instruction, and champion collaboration while addressing individual differences (Gustafson & Branch, 2002). Jonassen (1991) posited that learners construct knowledge actively instead of mere receive information passively. Uribe, Klein, and Sullivan (2003) underscored the positive effects of computer-aided collaborative learning on learners' performance in solving problem-based tasks. Further, instructional design experts maintained that sound lessons start with the awakening of learners' interest and then progress to presentation of new material, engaging learners in practice with feedback, establishing learners' understanding, and culminates in facilitating supplementary activities for continuity (Smaldino, Lowther, & Russell, 2012). Indeed, ASSURE model is learner centered (Sezer, Yilmaz, & Yilmaz, 2013) thus highly appropriate in achieving the competency required for the specified lesson.

2. Material and Methods

Anchored on McNiff's (1988) sequence - plan, act, observe, and reflect, this educational action research (Collier, 1945) put into operation the ASSURE (Heinich et al., 1993) learning design to develop students' competence in converting numerical data between each number system. It involved all twenty four 9th Graders taking up Creative Technologies under the Special Science Program in Laoang National High School, Northern Samar Division during the school year 2018 – 2019. Technology, media, and materials used in the instruction included smartphones, wi-fi, online number systems converter, videos, pictures, paper and ballpen. Technology integration is the use of computers and other technologies to support the task of teaching and learning (AACE, 2003).

Research instruments were comprised of survey questionnaires, focus group discussion, unstructured interviews, documents, participant observation, and teacher-made test. The survey questionnaire focused on the profile particularly age, sex, 4P's recipient, gadget owned, internet access, and residence; Perceptual Learning Styles (Reid, 1987); and Motivational Factors (McInerney, Dowson, & Yeung, 2005). A series of teacher-made test was used to gauge the level of manual conversion ability of the research participants. These revised instruments were subjected to content validity and reliability testing. Two English teachers examined them to ensure they fell within the comprehension level and cultural orientation of the students and then pre-tested. Moreover, descriptive statistics, thematic analysis (Braun & Clarke, 2013) and document analysis were employed to analyze the quantitative and qualitative data. At the 16th transcript data saturation was met.

2.1 Ethical Considerations

The researcher conscientiously followed the ethical research principles such as, honesty, objectivity, integrity, carefulness, openness, respect for intellectual property, confidentiality, competence and legality (Resnik, 2015). The participants were not harmed nor deceived (Sudman, 1998). Through an informed consent form, they became aware of the research objectives and they expressed willingness to participate by affixing their signature (Resnik, 2015; Sudman, 1998). The confidentiality of their responses and anonymity of their identities (Resnik & Master, 2011) were secured as there were no names mentioned in any part of the manuscript while the transcripts were made available only to them and selected evaluators. Careless errors and negligence were avoided (Resnik, 2015) as cautious safekeeping and critical examination of gathered data were highly observed. Further, there was a high regard for gender and family orientation thus the research was non-discriminatory (Resnik, 2015).

2.2 Trustworthiness of Qualitative Results

Trustworthiness consists of four different components (Bryman, 2012; Loh, 2013; Veal, 2011): (1) credibility pertains to the validity of the findings; (2) transferability refers to the applicability of the findings in other contexts; (3) dependability covers the reliability of the findings at another time; and (4) confirmability encapsulates objectivity of the researcher while carrying out his/her research. Credibility of the findings was achieved by prolonged engagement with the participants during the week-long class sessions, persistent observations while they were doing the activities, triangulation using varied sources of data, referential adequacy, peer debriefing with colleagues and a university assistant professor, and member checking with the participants over the codes and themes (Lincoln & Guba, 1985). By subjecting the participants to a series of activities that gave them very rich experience and collecting thick descriptions of their actions, transferability was addressed. Further, dependability has been established through credible data collection and analysis. Lastly, written interview responses, field notes, test results, survey results as well as transcripts and code structures provided the raw data which served as strong bases of the results' confirmability.

3. Results and Discussion

3.1 The Learners

A thorough analysis of the learners were administered the results of which guided the researcher in designing the lesson using ASSURE model.

As shown in table 1, the learners were female dominated (79%), at the right age (66.67%), indigents (79.16%), owned smartphones (54.16%), accessed the internet only through free data (54.16%), and lived in rural areas (58.33%). According to Agbamuche (2015), cultural attitudes, school locations, and equity/gender issues affect the use of technologies in schools. Because of this, the researcher borrowed two wi-fi devices and made his two smartphones available for them to use during class activities. Also, from his own pocket, he spent Php 500 for the internet access utilized through the whole duration of the intervention.

Table 1. Profile of the Learners

	Frequency	Percentage
Sex		
Male	5	21%
Female	19	79%
Total	24	100%
Age		
15 – 16	8	33.33%
13 – 14	16	66.67%
Total	24	100%
4P's (Pantawid Pamilyang Pilipino Program)		
Recipient	19	79.16%
Non-recipient	5	20.83%
Total	24	100%
Gadget owned		
Smartphone	13	54.16%
Cellular phone	11	45.83%
Total	24	100%
Internet access		
pre-paid data	0	0%
Free data	13	54.16%
None	11	45.84%
Total	24	100%
Residence		
Town proper	10	41.66%
Barrio	14	58.33%
Total	24	100%

On the other hand, table 2 showed that auditory was the major while tactile was the minor learning style of most learners. As Dunn and Dunn (1992) explained, some students learn through auditory channels, others attack problems by looking into specific details, while others like to move around and use tangible learning resources. In order to cater to this, the instructional design allowed learners to discuss, with modulated voice, among themselves the conversion process. Moreover, through their smartphones, they key in values on an online number system converter for analysis.

Table 2. Perceptual Learning Style of the Participants

	Visual		Auditory		Kinesthetic		Tactile		Group		Individual	
	f	%	f	%	f	%	f	%	f	%	f	%
Major	13	54%	15	63%	14	58%	8	33%	13	50%	14	58%
Minor	11	42%	9	33%	10	38%	15	58%	11	46%	8	29%
Negligible	0	0%	0	0%	0	0%	1	4%	0	0%	2	8%

Further, table 3 revealed that most of the learners were very strongly motivated when given task but very slightly motivated with social power. Anchored on this, the researcher assigned no leaders rather, they were given the freedom whom to discuss with as they fulfilled the task of figuring out the conversion process through technology specifically smartphone and online number systems converter. Promptly, feedbacks were given as regards the progress of their analysis. This is reinforced by (Gagné et al., 1992) who articulated that ASSURE Model stimulates students' interests through hands-on experience of using technology.

Table 3. Motivational Factors of the Participants

	Very strongly motivated		strongly motivated		Moderately motivated		Slightly motivated		Poorly motivated	
	f	%	f	%	f	%	f	%	f	%
Task	22	96%	1	4%	0	0%	0	0%	0	0%
Effort	14	61%	8	35%	1	4%	0	0%	0	0%
Competition	3	13%	9	39%	6	26%	3	13%	2	9%
Social Power	2	9%	8	35%	9	39%	1	4%	3	13%
Afiliation	9	39%	8	35%	5	22%	1	4%	0	0%
Social Concern	7	30%	12	52%	4	17%	0	0%	0	0%
Praise	6	26%	6	26%	10	43%	1	4%	0	0%
Token	5	21%	6	25%	11	46%	1	4%	1	4%

3.2 Learner Achievement

Table 4 exhibits an increasing percentage of learners who obtained outstanding achievement in the test given for each manual conversion problem. This reflected the adjustments they had to make in analyzing the results of the digital converter. In support to this, their answer sheets showed the processes they formulated for manual conversion. Participant observation by the researcher reinforced this as they were seen writing down a number of ways in converting manually which was also heard from their discourses as they exchanged ideas. Underpinning this, Sundayana, Herman, Dahlan, & Prahmana (2017) concluded that students mathematical ability improves through ASSURE learning design.

Table 4. Learner Achievement

	Percentage of Learners							
	Dec-Bi		Dec-Hex		Dec-Octal		Dec-BCD	
	f	%	f	%	f	%	F	%
90 & above (outstanding)	14	58%	19	79%	23	96%	24	100%
85-89 (Very Satisfactory)	2	8%	1	4%	1	4%	0	0%
80-84 (Satisfactory)	0	0%	1	4%	0	0%	0	0%
75-79 (Poor)	0	0%	0	0%	0	0%	0	0%
74 & below (Did not meet expectation)	8	33%	3	13%	0	0%	0	0%

Expounding into how their manual conversion skill came into actuality, the learners conveyed that the instructional design with technology integration made manual conversion easy and quick, guided in-depth analysis of conversion process, and encouraged knowledge sharing as shown in table 5. The learners claimed that "*computation was not difficult*" and even "*conversion of larger numbers is easy and quick*." Interestingly, a learner averred that "I *learned through my smartphone.*" In support, Ertmer, Rose, & Gopalakrushman (2007) claimed that technologies (i.e. media, internet, gadgets, audio-visuals) foster quicker learning. Theodorio (2012 cited by Theodorio, Theodorio, & Morakinyo, 2018) opined that technology integration makes learning simple and direct.

Further, the technology steered their analysis of the sample results. They figured out the conversion process by "*inspecting thoroughly how and what to do in getting the correct formula.*" When two sample conversion results were not enough, some of them "*tried different numbers and thoroughly analyzed the results until I learned the processes involved."* This showed that the learners used technology tools to enhance learning, increase productivity, and promote creativity (International Society for Technology Education, 2007). According to Dunn and Dunn (1992), some students are reflective in solving problems.

Moreover, the instructional design encouraged learners to share knowledge. As one argued, "*I asked help from my classmates then we obtained the correct answer*." Some were willing to teach others, "*my classmates asked me a lot of questions*." Consistent with their claims, the researcher observed them scribbled solutions on scratch papers. Those without smartphones walked to the other side of the room to join the in-depth analysis. With modulated voice, their discourses centered on formulating the steps in converting the number systems manually. This was possible since technologies nurture collaborative learning when used in classroom instructions (Ertmer et al., 2007). Dunn and Dunn (1992) articulated that some learners thrive in group work and companion of others. Conferring to this, Buchanan (2000) posited that not only is a good design creative and stylistic, but it also paves the way for more human engagement in its activities.

Table 5. Themes and Noteworthy statements

Global themes	Organizing themes	Noteworthy statements
make manual conversion easy and quick	○ easy manual conversion ○ faster conversion ○ learn through cellphone ○ quicker manual conversion	○ *Computation was not difficult* (transcript 1, line 28) ○ *Conversion of larger numbers is easy and quick* (transcript 11, lines 125-126) ○ *I learned through my smartphone* (transcript 11, lines 125-126)
guide in-depth analysis of conversion process	○ guide analysis ○ in-depth analysis ○ analyze the pattern ○ guide manual conversion ○ use more examples ○ do trial and error	○ *By inspecting thoroughly how and what to do getting the correct formula* (transcript 14, lines 163-164) ○ *I tried different numbers and thoroughly analyzed the results until I learned the processes involved* (transcript 17, lines 211-212)
encourage knowledge sharing	○ seek classmate's assistance ○ study the module with seatmate ○ teach classmates	○ *I asked help from my classmate then we obtained the correct answer* (transcript 8, lines 94-95) ○ *My classmates asked me a lot of questions* (transcript 17, 215-216)

4. Conclusion

It can be deduced that ASSURE instructional design enabled the learners to deepen their understanding of the types of number systems. Also, it enhanced their efficiency in using the technology as guidepost in manually converting between number systems. Further, this model stimulated their ingenuity in constructing step by step process for manual conversion. With this model, teachers could maximize technology's usability and provide learning experience commensurate to the level and background of the students. Moreover, school administrators could utilize it as tool in enhancing their instructional supervision ability.

References

AACE. (2003). Association for the Advancement of Computing in Education. Retrieved September 9, 2018, from http://www.aace.org/

Agbamuche, S. C. (2015). The use of electronic media in Nigerain Educational System: Principles, practice, problems and prescription, *42*. Retrieved from www.iste.org

Braun, V., & Clarke, V. (2013). *Successful qualitative research: A practical guide for beginners*. *SAGE*. London: SAGE Publication.

Bryman, A. (2012). *Social Research Methods* (4th ed.). Oxford: Oxford University Press.

Buchanan, R. (2000). Good Design In The Digital Age. *Gain: AIGA Journal of Design For the Network Economy*, *1*(1).

Collier, J. (1945). United States Indian Administration as a laboratory of ethnic relations. *Social Research*, *12*(3), 265–303.

Dar, C. C. (2017). *DepEd intensifies use of ICT in school and office management | Philippine Information Agency*. Baguio City. Retrieved from http://pia.gov.ph/news/articles/1002520

Department of Education. Guidelines on the Implementation of the DepEd Computerization Program (DCP) | Department of Education, Pub. L. No. 78, DepEd Orders (2010). deped.gov.ph. Retrieved from http://www.deped.gov.ph/2010/06/10/do-78-s-2010-guidelines-on-the-implementation-of-the-deped-computerization-program-dcp/

Dunn, R., & Dunn, K. (1992). *Teaching secondary students through their individual learning styles*. Boston: Allyan & Bacon.

Ertmer, P., Rose, E., & Gopalakrushman, S. (2007). Technology-using teachers: How power visions and students-centered beliefs fuel exemplary practice.

Gagné, R. M., Briggs, L. J., & Wager, W. W. (1992). *Principles of instructional design* (4th ed.). New York: Harcourt Brace Janovich College Publishers.

Gustafson, K. L., & Branch, R. M. (2002). *What is instructional design?* (R. A. R. & J. A. Dempsey, Ed.), *Trends and Issues in Instructional Design and Technology*. Saddle River, NJ: Merrill/Prentice-Hall. Retrieved from https://www.researchgate.net/publication/292056767_What_is_instructional_design

Heinich, R., Molenda, M., & Russell, J. D. (1993). *Instructional media and the new technologies of instruction*. Macmillan Pub. Co. Retrieved from https://books.google.com.ph/books/about/Instructional_Media.html?id=_ysiAQAAIAAJ&redir_esc=y

International Society for Technology Education. (2007). ISTE | Standards For Students. Retrieved August 25, 2018, from http://www.iste.org/standards/for-students?sfvrsn=2

Jonassen, D. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology: Research and Development*, *39*(5), 5–14.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: SAGE Publication.

Loh, J. (2013). Inquiry into Issues of Trustworthiness and Quality in Narrative Studies: A Perspective. *The Qualitative Report*, *18*(65), 1–15. Retrieved from http://www.nova.edu/ssss/QR/QR18/loh65.pdf

McInerney, D. M., Dowson, M., & Yeung, A. (2005). Facilitating conditions for school motivation: Construct validity and applicability. *Educational and Psychological Measurement*, *65*(6), 1046–1066. https://doi.org/10.1177/0013164405278561

McNiff, J. (1988). *Action Research: Principles and Practice*. London: Rutledge.

Megaw, A. E. (2006). Deconstructing the Heinich, Molenda, Russell, and Smaldino instructional design model.

Number Systems - Online Digital Electronics Course. (n.d.). Retrieved August 25, 2018, from http://electronics-course.com/number-systems

Reid, J. (1987). *The learning style preferences of ESL students*. TESOL.

Resnik, D. B. (2015). What is Ethics in Research & Why is it Important? Retrieved September 8, 2018, from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

Resnik, D. B., & Master, Z. (2011). Criteria for Authorship in Bioethics. *American Journal of Bioethics*, *11*(10), 17–21. https://doi.org/10.1080/15265161.2011.603795

Sezer, B., Yilmaz, F. G. K., & Yilmaz, R. (2013). INTEGRATING TECHNOLOGY INTO CLASSROOM: THE LEARNER-CENTERED INSTRUCTIONAL DESIGN. *International Journal on New Trends in Education and Their Implications*, *4*(4), 1.

Smaldino, S. E., Lowther, D. L., & Russell, J. D. (2012). *Instructional Technology and Media for Learning* (10th ed.). Upper Saddle River, NJ: Prentice Hall. Retrieved from https://www.pearson.com/us/higher-education/product/Smaldino-Instructional-Technology-and-Media-for-Learning-10th-Edition/9780138008154.html

Sudman, S. (1998). Survey Research and Ethics. *Advances in Consumer Research*, *25*, 69–71. Retrieved from http://acrwebsite.org/volumes/8127/volumes/v25/NA-25

Sundayana, R., Herman, T., Dahlan, J. A., & Prahmana, R. C. I. (2017). Using ASSURE learning design to develop students' mathematical communication ability. *World Transactions on Engineering and Technology Education*, *15*(3).

Theodorio, A. O. (2012). *Teachers' perception of integrating the use of mobile phones into teaching in public senior secondary schools in Oyo and Lagos States*. University of Ibadan.

Theodorio, A. O., Theodorio, F. J., & Morakinyo, T. O. (2018). Reengineering the ASSURE model to curbing problems of technoogy integration in Nigerian learning institutions. *Association for Learning Technology*, *26*. Retrieved from journal.alt.ac.uk/index.php/rlt/article/view/1999/html

Uribe, D., Klein, J. D., & Sullivan, H. (2003). The effect of computer‐mediated collaborative learning on solving ill‐defined problems. *Educational Technology: Research and Development*, *51*(1), 5–19.

Veal, A. J. (2011). *Research Methods for Leisure and Tourism* (4th ed.). England: Pearson Education Limited.