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Development of An Instrument for Measuring the Student Learning Outcomes: A Content Validation Process

Sushant Handage[1] and Mahesh Chander[2]*

[1]PhD Scholar, [2]Principal Scientist & Head, Division of Extension Education, ICAR-Indian Veterinary Research Institute, Izatnagar–243122, Bareilly, Uttar Pradesh
*Corresponding author email id: drmahesh.chander@gmail.com

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ABSTRACT

Content validation is a critical phase in scale development. It provides the preliminary evidence on construct validity of an instrument. The content validation process followed in developing a scale designed to measure the student learning gains is explained in detail. Content validation involves two stages, identification of the content domain and item generation, and determining the content validity. A mixed deductive-inductive method was adopted for item generation. The content validity was assessed in two rounds, in the first round the Content Validity Ratio (CVR) was computed and the items with CVR critical value of 0.407 or above were accepted and subjected to computation of Content Validity Index (CVI) in the second round. Modified kappa values were determined to overcome the chance factor. The Item-Content Validity Index (I-CVI) values were computed to finalise the items in the final scale while the Scale-Content Validity Index (S-CVI) was determined to check for stability of each dimension as well as the scale as a whole. The CVI value above 0.78 was considered fit for the scale.

INTRODUCTION

As science advances and novel research questions emerge, new scales become imperative especially in the fields of sociology, social psychology, and other social sciences. Scales are the manifestation of latent constructs and are developed to measure behaviour, attitude, perception and/or hypothetical scenarios that are believed to subsist as a result of theoretical understanding (DeVellis, 2016). Many researchers develop items for surveys with the intent of measuring a latent construct but are not confident enough with the content validity. To overcome this jargon, they depend on expert opinion to review their items. However, the biggest hurdle here is identifying experts who are highly knowledgeable about the domain of interest. Not all the professionals who are qualified in a given subject act as an expert, if the domain is not of his/her interest. But, to seek a larger consensus, the experts are approached who are professionally connected to a subject but may not be connected to the research domain and often end up with a misleading opinion. Thus, in order to establish content validity for a conceptualized instrument, a consensus approach with a fewer but domain specific experts who can critically review and critique an assessment tool may be considered a good practice.

Content validity is defined as “the degree to which items of an assessment instrument are representative and relevant to the targeted construct” (Cook and Beckman, 2006). Content validity provides the preliminary evidence on construct validity of an instrument. If an instrument lacks content validity, it is impossible to establish reliability for it. For establishing content validity most researchers used judgement of experts (Kumar et al., 2015; Kumar et al., 2016; Priyadarshni et al., 2021). Present research aimed to discuss the content validation process followed in developing a scale designed to measure the student learning gains in extension education post-graduation. Student learning gain may be defined as the improved students’ capabilities as a consequence of their study at a particular institute or university (Bennet, 2001). No college or university develops a single competency in students; all try to

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develop an array of capabilities. Bhuvaneswari and Dharanipriya (2020) discovered the influencing factors of student e-learning to bring in betterment in the e-learning system. Measurement of student gains must therefore attend to a number of different dimensions.

METHODOLOGY

Typically, the scale development involves three phases: item development phase, scale development phase, and the scale evaluation phase. The first phase, i.e., item development phase is a critical phase involving two major stages namely identification of the content domain and item generation, and determining the content validity. Subsequently, the scale enters into the second phase i.e., scale development involving pretesting of scale, Conduct of survey, item reduction and extraction of latent factors. The last phase i.e., scale evaluation, follows testing dimensionality, testing reliability, and testing validity. This research highlights the item development phase in detail that was practiced in developing the scale for measuring the student learning gains. The item development phase follows the following two major stages:

Identification of the content domain and item generation

Content domain is the content area represented through the variables that are intended to be measured (Beck and Gable, 2001). The content domain was determined through literature review, and focussed discussion with the expert and the target group. A mixed deductive-inductive method was adopted for conceptualization and item generation. After the item generation, items were refined and organized in a suitable format and sequenced so that the finalized items were in a usable form.

Determining the content validity

Relevance and representativeness are the two key aspects to be fulfilled in content validation (Polit and Beck, 2006). The content validity was assessed in two rounds. In the first round, essentiality of the items and domains were validated by computing the CVR values. Additionally, feedback was sought from the experts for meeting the deficiencies in the construct like any missing domain or items, vocabulary, grammatical errors as a resultant of researcher biasness. In the second round the relevancy of the scale was determined by computing the content validity index (CVI). Thus, any faux pas that could have occurred in the first round gets revalidated in second round. A minimum of five experts and up to ten experts are recommended for content validation (Newman et al., 2013). Researchers always seek a larger panel to have sufficient control over the chance agreement. For the present study, 27 experts were approached in the first round and 14 experts in the second round. It is believed that when we have a limited panel size, it is easy to establish the relevancy, representativeness, clarity, and comprehension of items in order to ensure the content validity (Wynd et al., 2003). Yadav et al., (2018) approached thirty judges to ensure relevancy of statements in a scale developed to measure attitude of people about agriculture biotechnology.

Content validation procedure

The first step in content validation was to develop a content validation form to ensure the experts have clear understanding about the task. Proper instruction and appropriate rating scale were employed in the study. Judges were requested to critically review the dimensions and the items before scoring on each item. They were asked to score on a 1 to 3 continuum "*not necessary, useful but not essential,* and *essential*" respectively. Content validity ratio (CVR) is computed using the formula,

$$CVR = (Ne-N/2) / (N/2)$$

Where, Ne is the number of judges indicating "essential" and N is the total number of judges.

CVR value is determined by Lawshe Table. The values range from –1 (perfect disagreement) to +1 (perfect agreement) and value above zero indicates that more than half of judges agree an item essential. However, it is important to consider whether this level of agreement could be a chance factor. To overcome this, Lawshe adopted a table of critical CVR values ($CVR_{critical}$) computed by Lowell Schipper, where it was assumed that the level of agreement exceeds that of chance for a given item. For a panel size of 27, the CVR critical value is 0.407 (Ayre and Scally, 2014). Content validity index (CVI) is widely used index in quantitative evaluation. There are 2 types of CVI: I-CVI (item level) and S-CVI (scale level). After establishing the CVR and retaining the items with acceptable level of significance, the instrument is redesigned with necessary modifications and subjected once again to the panel of judges to assess the (CVI) for item (I-CVI) and scale (S-CVI). Prior to the calculation of CVI, the scale is dichotomized by recoding all responses with 3 and 4 as 1 and all responses with 1 and 2 as zero. Where 1 means 'relevant' and 0 means 'not relevant'.

I-CVI = Experts in Agreement/ Total No. of experts

S-CVI = The average of proportion relevance scores across all experts

Table 1. The number of judges and its influence on the acceptable cut-off score of CVI

No. of Judges	Acceptable CVI values	Recommendations
2	At-least 0.8	Davis 1992
3 to 5	Should be 1	Polit & Beck (2006), Polit et al., (2007)
At-least 6	At-least 0.83	Polit & Beck (2006), Polit et al., (2007)
6-8	At-least 0.83	Lynn 1986
At-least 9	At-least 0.78	Lynn 1986

Although CVI is extensively adopted to estimate content validity, there may be chances of inflated values due to chance agreement. Hence, Wynd et al. (2003) proposed both CVI and multi-rater kappa statistic in content validation because, unlike the content validity index, it calibrates for chance agreement (Wynd et al., 2003). When we adopt a four-point continuum within two relevant and non-relevant classes, chance agreement stands an issue while studying the agreement indices (Zamanzadeh et al., 2015). In particular, kappa statistic stands an important supplement to content validity index as the kappa value provides information of the degree of agreement that is beyond chance (Wynd et al., 2003). However, to calculate modified kappa statistic, one has to first calculate the probability of chance agreement for each item by following formula:

$$Pc = \left[\left(\frac{N!}{A!}\right)(N-A)!\right] * 0.5^{N}$$

Where, N= number of judges in a panel and A= number of judges agreeing an item as relevant.

Kappa was calculated using the values of probability of chance agreement (PC) and I-CVI values through the following formula:

$$K = \frac{\text{I CVI -Pc}}{\text{1-Pc}}$$

Kappa values above 0.74 were regarded as excellent, between 0.60 and 0.74 as good and between 0.40 and 0.59 as fair (Cicchetti and Sparrow, 1981). According to Polit, I-CVI value equal to or higher than 0.78 for judges beyond 10 was considered excellent even after controlling the items through adjusted kappa. With the increase in the number of experts, the probability of chance agreement (P_c) decreases and I-CVI and kappa tend to converge (Zamanzadeh et al., 2015). The last step in the content validity process is to evaluate the comprehensiveness of each dimension and the instrument as whole. The panel members were requested to judge whether the instrument dimensions were complete and comprehensive representation with respect to the theoretical definitions of concepts are concerned. To assess the scale comprehensiveness, the number of judges who identified the instrument comprehensiveness as favourable was divided by the total number of judges.

RESULTS AND DISCUSSION

Stage 1: Identification of domain and item generation

In this stage, content domain with six dimensions including conceptual understanding, basic extension skills, basic technical skills, research and evaluation skills, integration of learning, and motivation towards the course were identified. A total of 142 items were generated from these dimensions. The items were then examined for duplication, overlapping and appropriateness. Finally, 110 pooled items were retained within the six dimensions.

Stage 2: Determination of content validity

Content validation process began with the preparation of an appropriate content validation form to ensure that the review panel will have clear instructions and understanding about the task. The content validation form for the study was designed as in Table 1 and 2.

Selection of the review experts

The experts for the present study were carefully selected based on the individual expertise with the research topic. A total of 27 experts were contacted for the first round to establish the CVR. The panel consisted of teaching faculty, scale construction experts, and recently passed PhD graduates. The judges' number was arbitrary and followed a snowball sampling pattern, where initially the known experts were contacted and based on their referrals other experts were contacted. The second round was limited to 14 experts. Most of the experts in second round were from the first list.

Reviewing domain and items

After the responses from 27 experts were received, the items were subjected to estimation of content validity ratio (CVR). All the items with $CVR_{critical}$ value of below 0.407 were eliminated from the scale. Figure 1 shows the CVR values obtained at the first round of judgement. The items below the horizontal axis line (CVR critical 0.407) were eliminated from the scale. Thus, at the end of round 1 of judgement, the scale was tuned to 59 items. Helen and Khaleel (2009) consulted expert judges to reduce their sixteen dimensions to ten based on judge's opinion. Among the finalised items, few were modified based on the expert recommendations. This round has a wider rejection zone (-1 to 0.406) as only the items with $CVR_{critical}$ value of 0.407 or higher will appear in the scale.

Fifty-nine items from round 1 were then subjected to CVI calculation in the second round. Here the judges score the items on

Table 2. Content validation form prepared for round 1 (Establishing CVR)

Dear expert
This instrument is designed to measure the student learning gains in extension education post-graduation. This domain consists of 6 dimensions with a total of 110 items. We need your expert judgement on the essentiality of the dimension as a whole, as well as individual items developed for the study. We also expect a written feedback to sushXXXXX@gmail.com for necessary inclusions, deletions or modifications that may be important consideration. You may also call on 99XXXXXXXX. Please be as objective and constructive as possible in your review and use the following rating scale

Degree of essentiality:
1: item not necessary
2: item useful but not essential
3: item essential

Table 3. Content validation form prepared for round 2 (Establishing CVI)

Dear expert
This instrument is designed to measure the student learning gains in extension education post-graduation. This domain consists of 6 dimensions with a total of 59 items. We need your expert judgement on the relevance of the items to the target construct. Please be as objective and constructive as possible in your review and use the following rating scale

Degree of relevance:
1: item not relevant to the measured domain
2: item somewhat relevant to the measured domain
3: item quite relevant to the measured domain
4: item highly relevant to the measured domain

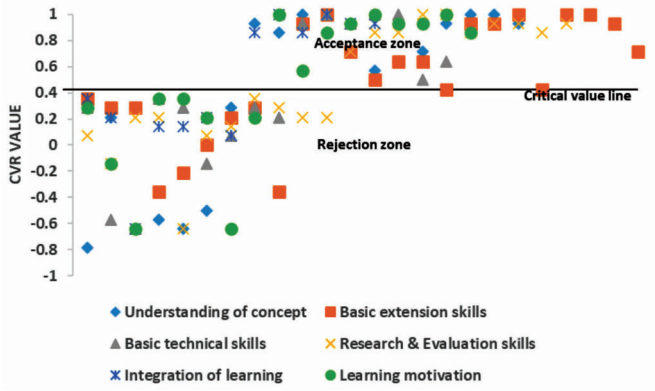

Figure 1. CVR values obtained for the instrument items at the first round of judgement

a four-point continuum according to Waltz and Baussel (1981) content validity index. Items with CVI score less than 0.78 were eliminated in this round of judgement. Table 4 shows the values for I-CVI, S-CVI, modified kappa and comprehensiveness of dimension and overall scale. If the CVI value is higher than 0.78, the item is considered as appropriate. If it was between 0.7 to 0.78, it was considered with some modifications or revision. If the value was below 0.7, the item was not fit to be considered (Abdollahpour et al., 2010). Cicchetti and Sparrow (1981) described that Kappa values of 0.4 to 0.59 as fair, 0.6 to 0.74 as good and above 0.74 as excellent.

Five items got eliminated in this round. The final scale, at the end of content validation procedure, is presented in Table 5, which was further subjected to determination of face validity, and construct validity.

Table 4. Content validity index, modified kappa and comprehensiveness of dimensions at the second round of judgement

	Experts in Agreement	I-CVI*	Pc**	K***	Interpretation	Comprehensiveness of overall instrument	
						Agree	Proportion
LO1: Understanding of concept							
LO1-1	14	1	6.103	1	Accepted	14	1
LO1-2	13	0.93	0	0.928	Accepted		
LO1-3	14	1	6.103	1	Accepted		
LO1-4	14	1	6.103	1	Accepted		
LO1-5	14	1	6.103	1	Accepted		
LO1-6	12	0.86	0.022	0.854	Accepted		
LO1-7	13	0.93	0	0.928	Accepted		
LO1-8	13	0.93	0	0.928	Accepted		
LO1-9	14	1	6.103	1	Accepted		
LO1-10	14	1	6.103	1	Accepted		
LO1-11	14	1	6.103	1	Accepted		
LO1-12	14	1	6.103	1	Accepted		
	S-CVI	0.970					
LO2: Basic extension skills							
LO2-1	14	1.00	6.103	1.000	Accepted	14	1
LO2-2	14	1.00	6.103	1.000	Accepted		
LO2-3	12	0.86	0.022	0.854	Accepted		
LO2-4	10	0.71			Eliminated		
LO2-5	13	0.93	0	0.928	Accepted		
LO2-6	13	0.93	0	0.928	Accepted		
LO2-7	10	0.71			Eliminated		
LO2-8	14	1.00	6.103	1.000	Accepted		
LO2-9	13	0.93	0	0.928	Accepted		
LO2-10	14	1.00	6.103	1.000	Accepted		
LO2-11	9	0.64			Eliminated		
LO2-12	14	1.00	6.103	1.000	Accepted		
LO2-13	14	1.00	6.103	1.000	Accepted		
LO2-14	14	1.00	6.103	1.000	Accepted		
LO2-15	14	1.00	6.103	1.000	Accepted		
	S-CVI/Ave	0.9143					
LO3: Basic technical skills							
LO3-1	13	0.93	0	0.928	Accepted	12	0.857
LO3-2	14	1.00	6.103	1	Accepted		
LO3-3	13	0.93	0	0.928	Accepted		
LO3-4	14	1.00	6.103	1	Accepted		
LO3-5	14	1.00	6.103	1	Accepted		
LO3-6	10	0.71			Eliminated		
LO3-7	9	0.64			Eliminated		
	S-CVI/Ave	0.888					
LO4: Research and evaluation skills							
LO4-1	13	0.93	0	0.928	Accepted	14	1
LO4-2	14	1.00	6.103	1	Accepted		
LO4-3	13	0.93	0	0.928	Accepted		

Table 4 contd...

	Experts in Agreement	I-CVI*	Pc**	K***	Interpretation	Comprehensiveness of overall instrument	
						Agree	Proportion
LO4-4	14	1.00	6.103	1	Accepted		
LO4-5	14	1.00	6.103	1	Accepted		
LO4-6	12	0.86	0.022	0.854	Accepted		
LO4-7	13	0.93	0	0.928	Accepted		
LO4-8	14	1.00	6.103	1	Accepted		
LO4-9	13	0.93	0	0.928	Accepted		
LO4-10	14	1.00	6.103	1	Accepted		
	S-CVI/Ave	0.957					
LO5: Integration of learning							
LO5-1	13	0.93	0	0.928	Accepted	14	1
LO5-2	14	1	6.103	1	Accepted		
LO5-3	12	0.86	0.022	0.854	Accepted		
LO5-4	14	1	6.103	1	Accepted		
LO5-5	13	0.93	0	0.928	Accepted		
LO5-6	13	0.93	0	0.928	Accepted		
	S-CVI/Ave	0.952					
LO6: Motivation towards course							
LO6-1	14	1	6.103	1	Accepted	13	0.928
LO6-2	12	0.86	0.022	0.854	Accepted		
LO6-3	14	1	6.103	1	Accepted		
LO6-4	13	0.93	0	0.928	Accepted		
LO6-5	14	1	6.103	1	Accepted		
LO6-6	12	0.86	0.022	0.854	Accepted		
LO6-7	13	0.93	0	0.928	Accepted		
LO6-8	14	1	6.103	1	Accepted		
LO6-9	12	0.86	0.022	0.854	Accepted		
	S-CVI/Ave	0.937					
		Overall scale S-CVI/Ave 0.930				Agreement on total comprehensiveness of scale = 0.964	

Table 5. Final scale depicting the CVR and I-CVI values at the end of Content validity process

#	Code	Items	CVR	I-CVI
LO-1		Understanding of concept		
		I understand the…		
1	LO1-1	Vision, mission, and goals of extension	0.928	1.00
2	LO1-2	How extension is different as a profession from extension as a discipline	0.857	0.93
3	LO1-3	National agricultural development strategies, programs, and policies	1	1.00
4	LO1-4	Basic techniques to assess farmer learning needs	0.857	1.00
5	LO1-5	Local/ state/ national agricultural development trends	0.928	1.00
6	LO1-6	How to engage stakeholders in implementing local programs	0.571	0.86
7	LO1-7	How to actively establish working relationship with community leaders	0.642	0.93
8	LO1-8	Group dynamics and effective team member roles	0.714	0.93
9	LO1-9	Basic approaches to conflict resolution	0.928	1.00
10	LO1-10	Facilitation and the role of facilitator	1	1.00
11	LO1-11	Different leadership approaches	1	1.00
12	LO1-12	How to practice consensus in decision making	0.928	1.00
LO-2		Basic extension skills		
		I am able to…		
13	LO2-1	Confidently address public gatherings	0.928	1.00
14	LO2-2	Build rapport with farmers	1	1.00
15	LO2-3	Deliver effective presentations	0.714	0.86
16	LO2-5	Develop educational videos for farmers	0.642	0.93
17	LO2-6	Design an effective teaching material	0.642	0.93
18	LO2-8	Write farm articles for a newspaper	0.928	1.00
19	LO2-9	Document farmer success stories	0.928	0.93
20	LO2-10	Develop script for radio/ television	1	1.00
21	LO2-12	Conduct a case study	1	1.00
22	LO2-13	Develop a reliable and valid interview schedule	1	1.00
23	LO2-14	Conduct and effectively involve in group discussion	0.928	1.00
24	LO2-15	Develop farm plans and project reports	0.714	1.00

Table 5 contd...

#	Code	Items	CVR	I-CVI
LO-3		Technical skills		
		I am able to…		
25	LO3-1	Use spreadsheets and MS access for data tabulations and analysis	0.928	0.93
26	LO3-2	Use social media and its analytics tool as an educational outreach medium	1	1.00
27	LO3-3	Developing and designing content strategy for mobile applications	0.928	0.93
28	LO3-4	Search for and make use of emerging online toolkits to connect farmers	1	1.00
29	LO3-5	Carry and make use appropriate devices for conveying an information effectively	1	1.00
LO-4		Research and evaluation skills		
		I am able to…		
30	LO4-1	Critically observe and interpret any given situation	0.714	0.93
31	LO4-2	Develop an effective research argument	0.857	1.00
32	LO4-3	Find articles relevant to a particular problem in professional journals or elsewhere	0.857	0.93
33	LO4-4	Design a valid survey or interview questions that align to research objectives	1	1.00
34	LO4-5	Select an appropriate sampling technique for a research project	1	1.00
35	LO4-6	Identify patterns in a data	0.857	0.86
36	LO4-7	Organize the data into graphs and tables	0.928	0.93
37	LO4-8	Write research documents in discipline-appropriate style and format	0.928	1.00
38	LO4-9	Follow the core principles of research ethics	0.857	0.93
39	LO4-10	Find appropriate research journal for publication based on nature of study	0.928	1.00
LO-5		Integration of learning		
		I am in the habit of…		
40	LO5-1	Figuring out how information learnt is useful in real world	0.857	0.93
41	LO5-2	Figuring out how information learnt might be useful to varied job context	1	1.00
42	LO5-3	Connecting ideas learnt to career outside the subject area	0.857	0.86
43	LO5-4	Following systematic reasoning in approach to problems	1	1.00
44	LO5-5	Working on complex ideas	0.928	0.93
45	LO5-6	Working independently	0.928	0.93
LO-6		Learning Motivation		
		I always feel to…		
46	LO6-1	Actively engage myself on assigned tasks	1	1.00
47	LO6-2	Help others in a team to perform well	0.571	0.86
48	LO6-3	Respect other person's views	0.857	1.00
49	LO6-4	Seek support from others when working on complicated tasks	0.928	0.93
50	LO6-5	Appreciating other persons success	1	1.00
51	LO6-6	Involve in constructive criticism with well-reasoned opinions	0.928	0.86
52	LO6-7	Follow rules and regulations devised to maintain order	0.928	0.93
53	LO6-8	Show pride when representing my organisation	1	1.00
54	LO6-9	Express loyalty towards and concern about the image of the organisation	0.857	0.86

CONCLUSION

The present study highlighted the content validation procedure for a new instrument. Scale validation itself was a lengthy process, in which content validation was the first step. In the next step, the analysis was directed towards reliability testing (internal consistency), and construct validity (factor analysis). As feedback is subjective in nature, the limitations with content validity process were the biasness with the responses among the judges and secondly, there were chances of content being omitted from the instrument by the researcher that could have been an important determinant of the construct. Hence, by adopting a two-stage content validation, the biasness was overcome and also the experts were asked to suggest other items for the instrument which helped in minimizing the researcher bias.

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