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Assessment Methods Required for Future Higher Agricultural Education Curriculum on Graduates 21st Century Skills in Eswatini

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Abstract
The 21st century requires that education systems deliver educational experiences relevant in today's world. This necessitates a shift from traditional to new learning domains characterised by transferable skills and competences needed by today's youth to thrive and participate fully in the economy. Any substantial educational change, therefore, must be followed by an alignment in areas of curriculum, pedagogy and assessment. Prior research identified a set of 21st century skills needed by University of Eswatini graduates to flourish in today's economy, and how they may be taught. However, no methods of assessing the skills have been determined. The study determines assessment methods required for higher agriculture education curriculum on 21st century skills. Study used a two-round modified Delphi Technique on Phase I to investigate concept dimension and sub-dimensions with agricultural education specialists in Eswatini. Phase II employed a survey to triangulate prior data collection method, population, and findings by using secondary agriculture teachers in Eswatini to establish assessment methods' gaps and highly ranked assessment methods for 21st century skills. Findings reveal that ten assessment methods primarily performance-based, diagnostic, summative, formative can be used to measure 21st century skills. Thus, the University of Eswatini should incorporate these into the higher agricultural education curriculum and deliberately use them to assess the 21st century skills in Eswatini's future agricultural education graduates. As a result, instructors from the Department of Agricultural Education and Extension would require sufficient training to effectively use the tools to assess potential graduates' 21st century skills.

Introduction

The United Nations' Sustainable Development Goal 4 (SDG 4) and the Education 2030 agenda (including Target 4.7) commit countries to children and students acquiring knowledge and skills in areas of sustainable development, human rights, gender equality and global citizenship, amongst others (Murugiah, 2020). African countries have also joined to develop Agenda 2063, asserting Africa's human capital is its most valuable resource fulfilled via persistent investments in education. Agenda 2063 demands that African policy-makers invest in skills, science, technology, engineering and mathematics so Africans can drive the continent's

development. These demands have been matched by strong acceptance of 21st century skills, for a significant and powerful shift in education. These skills, will render students to succeed after higher education learning (21st Century Skills Handbook, 2020). Policymakers in higher education institutions, must thus have strong knowledge of the skills most in demand in the digital world of the 21st century, how they relate to the orthodoxy academic standards, can be effectively taught and assessed.

Agricultural education in the 21st century is inevitable, as the world's population grows and faces a worldwide food security crisis. Hence, agricultural education must focus and recognize the soft skills for a successful human capital capable of solving today's and tomorrow's problems (Duerden et al., 2014). A recent survey co-sponsored by the Association of Public and Land Grant Universities (Crawford et al, 2011) revealed the crucial importance agriculture employers place on soft skills when recruiting personnel. They valued soft skills more than technical capabilities, which are usually the primary emphasis of university curriculum development. As a result, for a rich human capital of highly qualified, motivated, and well-trained agricultural scientists, agricultural education at the University of Eswatini (UNESWA) needs to be proactive with change. UNESWA needs to train future agricultural educators with the necessary 21st century skills. (Government of the Kingdom of *Swaziland*, 2018). A study by Gule, Alademerin and Dlamini (2023) has identified important 21st century skills required by agricultural education graduates in Eswatini. Debates, however, on how these skills can be assessed and the models to use to reflect today's world have been persistent. Care, Kim, Vista and Anderson (2018), emphasised that any major reform in an educational philosophy shift must ensure alignment across the areas of curriculum, pedagogy, and assessment (Cachia, Ferrari, Ala-Mutka, Punie, 2010). Ferrari, Cachia, Punie (2009) defined assessment as an essential component of learning and teaching, as it allows the quality of both to be judged and improved.

The Partnership for 21st Century Skills Report (2011)) on 21st century skills states that assessments should: measure learners' knowledge, application and learning of 21st century skills; identify where intervention is required; be applicable across a wide range of instructional programmes; and earners can demonstrate their proficiency in 21st century skills (Honey et al., 2005). Research also acknowledges that diverse tools are needed as a single assessment instrument cannot meet all these objectives (Redecker & Johannessen, 2013). Some measures were implemented for testing 21st century skills (Rottherham & Willinghan, 2009), but they have not been proved efficient and not commonly used. Lai and Viering (2012) reviewed literature on the skills of critical thinking, creativity, collaboration, motivation, and metacognition, and listed assessment methods such as self-reports, global rating scales, journal, formative, summative measures, standardised, journal, portfolio, and observational measures. Scales such as "California Critical Thinking Tendency Scale" developed by Facione and Giancarlo (1992) measuring the logical dimension of critical thinking were used in several studies for assessment of 21st century skills.

School-based agriculture education enables students to develop 21st century skills (Yoest & Kane, 2015). However, no studies to date in Eswatini concerning the assessment of these skills. Students' achievement only in the curriculum areas content in Eswatini were assessed mainly through formative and summative assessments. Although formative and summative assessments are used in the assessment of 21st century skills (Saavedra & Opfer, 2012), a common difficulty is, some skills are too subjective and enigmatic to be measured objectively. Since no evidence of any assessment of 21st century skills at UNESWA exists, the study seeks to close that gap.

Purpose of the Study

The purpose of the study was to identify the assessment methods required for higher agricultural education curriculum regarding 21st century skills in Eswatini. The specific objectives were to:

i. describe the background and demographic characteristics of respondents/participants in the study; and
ii. identify assessment methods that could be used to measure 21st century skills in future agricultural education graduates at UNESWA.

Findings from the study will be beneficial to UNESWA agricultural education instructors who will gain insights on appropriate assessment methods to adopt in order to assess the development of 21st century skills in future graduates. This will lead to a revised higher agricultural education curriculum with assessment models aligned with and reflective of the world graduates for today and the future.

Theoretical Framework of the Study

The Partnership for 21st Century Learning's Framework (Battelle for Kids, 2019) in Figure 1 serves as foundation for this paper. It focuses on how students can excel and succeed in the 21st century. The framework represents the "21st century student outcomes" which are skills, knowledge and expertise to master to succeed in work and life in the 21st century. Since developing a comprehensive framework for 21st century learning requires more than identifying specific skills, content knowledge, expertise and literacies, other supporting established systems such as: *21st Century Standards; Assessment of 21st Century Skills; 21st Century Curriculum and Instruction; 21st Century Professional Development;* and *21st Century Learning Environments* ensure students mastery of these skills have been added in the framework. The current study considers how one of the aforementioned can support mastery of 21st century skills. Without assessing the development of 21st century skills, it would be difficult to state that future higher agricultural education graduates will succeed in the world of work and life.

Figure 1:

P21's Frameworks for 21st Century Learning

(Battelle for Kids, 2019)

Methodology

The study was a mixed-methods research, employing two-phase exploratory sequential design.. Phase I utilised a census (all experts) two-round modified Delphi Technique of higher agricultural educators (n=8), agriculture inspectors in Eswatini (n=6), National Curriculum Centre personnel (5), and an agriculture examination moderator (n=1) indicated the assessment methods to be retained (Round 1) and then ranked in Round 2. These experts were appropriate due to their experience and knowledgeability. The sampling frame was supplied by respective institutions of the experts, controlling for frame error. Experts in 21st century skills are still in short supply; however, due to abundance of work available in literature, the concept, its dimensions and sub-dimensions were presented to the experts. Based on their expertise in agricultural education field, they were able to respond to the items provided, prioritising the important ones and specific to the discipline in Eswatini.

A questionnaire titled: *Higher Agricultural Education Curriculum Century Skills Questionnaire* (HAECCSQ version 1, 2 and 3) was developed and used for data collection. HAECCSQ 1 used in Round 1 sourced concept dimensions and sub-dimensions from the Framework of this study and additional relevant literature. The sub-dimensions included open and close-ended questions. In one section participants were requested to rate the priority level of each methods using a five-point rating scale from Very Low Priority (1) to Very High Priority (5). Additional comments and suggestions for other methods that could be used were also sought. Only those sub-dimensions that failed to attain consensus in Round 1 were escalated to Round 2. A consensus rate of 80% (summative of high priority and very high priority) was set *a priori* for each sub-dimension. The 80% consensus rate was meant to cover highly prioritised methods by the agricultural education experts. Table 1 shows the consensus criteria in the investigation.

Table 1:

Consensus Criteria for the Rated Sub-dimensions and Meanings Given

***Consensus Criteria on the -point rating scale (set a priori)**	**Decision**
Highly Essential if: ≥80% 4-5, IQR ≤1 and Median ≥4 *Desirable* if: 50%-79% 4-5, IQR >1, but < 2 and Median either ≥4 or <4 *Not Essential* if: ≤50% 4-5, IQR ≥2 and Median <4	*Endorsed = Banked* *Retained = Included in Round 2 questionnaire* *Rejected = Dropped*

*Developed by Authors

HAECCSQ 2 for Round 2 presented the previous round's results, including individual and group ratings. The results showed the level of agreement, interquartile range, and the median score. A 15% change level demonstrated that opinions were stable between the 2 rounds which is judged adequate for the cut-off point of opinion stability (Scheibe et al., 1975). Sub-dimensions from this phase were then used to create the survey instrument for Phase II (HAECCSQ 3). Data yielded trustworthiness in terms of credibility, reliability, transferability, and confirmability.

Validity of the quantitative instruments HAECCSQ 1 and HAECCSQ 2 depended on the fact that the Delphi is built on the notion of safety in numbers, meaning that a group of individuals

is less likely to make a bad judgment than a single person. Decisions are then enhanced through reasoned debate iterant rounds in which assumptions were challenged, aiding in the enhancement of validity (Hill & Fowles, 1975). Reliability for both instruments relied on the nature of the Delphi technique. The members of the experts' panel do not meet face to face in the decision-making process, which eliminates group bias (Keeney, Hasson & McKenna, 2011). Finally, it was not necessary to establish the reliability it in subsequent questionnaires as the modified Delphi technique is to encourage experts to modify their responses for group consensus (Shariff, 2015). Therefore, pre-testing was not performed in the. Issues of trustworthiness, credibility, dependability, confirmability and transferability, however, were addressed for qualitative data from Round 1. Evidence based on consensus ensured credibility and demonstrated through the use of peer review. Colleagues of the researcher were presented with the raw data from Round 1, along with the researcher's interpretations of the findings. Colleagues were asked: "*Given the evidence presented, is there a consensus in the interpretation?*" Discussions that followed then helped to determine whether the reviewers considered the interpretation to be reasonable, given the evidence. Problems were also identified by reviewers, were noted and rectified. Dependability was ensured by an audit trail and triangulation to ensure dependability of qualitative findings.

In the audit trail, the researcher kept thorough notes and records of activities that took place from the beginning (round 1) to the end (round 2) of the modified Delphi Technique. Information on the sample studied, the selection process, contextual descriptions, methods of data collection and other descriptive materials that could be reviewed by other people were provided and available to other researchers. Data collected from the panel of experts was kept safe and organized in a retrievable form (both in soft and hard copies). This enabled making a judgment about the replicability of the research within the limits of the natural context. Triangulation in data sources, data collection and data analysis ensured the dependability. Confirmability was achieved by peer review, audit trail and triangulation so that conclusions can be traced backwards and retraced forward. Lastly, transferability was by providing a rich, detailed, thick, descriptions of the research processes from the context, data collection, to the production of final report. The potential users can make the necessary comparisons and judgments about similarity of findings. Thematic analysis was used to analyse qualitative Round 1 data. Terry, Hayfield, Clarke, and Braun (2015) characterise thematic analysis as a more qualitative technique arguing for flexible coding and topic creation. The quantitative data from Rounds 1 and 2 were analysed using descriptive statistics of percentages, interquartile range, and median.

The survey was the Phase II. Its target population was all Eswatini high school agriculture teachers (N=404). A sample size (n=198) was obtained using Dillman's (2000) procedure. The simple random sampling using the lottery method was used. The HAECCSQ 3 with two sections was developed based on Phase I findings. Agricultural education specialists from Nigeria were given the study's purpose and established the content and face validity. The questionnaire was further verified for reliability by 30 secondary school agriculture teachers from across the country who were excluded during the sampling process. HAECCSQ 3 reliability coefficient was found to be r= 0.88, demonstrating high reliability. Data collected in Phase II were analysed using descriptive statistics frequencies, percentages, means and standard deviations. Ethical intents to get permission to conduct research (consent, reciprocation, no harm, beneficence, justice and respect for human dignity) were taken care of.

Findings and Discussions

Background and Demographic Information of Participants

Background and demographic characteristics of participants included were gender, age, marital status, highest degree, work experience, occupation, and position held at work (Table 2).

Table 2:

Joint Display Comparison of Background and Demographic Data from Phase I (two- rounds modified Delphi Technique, n = 17) and Phase II (Survey, n=198)

S/N	Variable	Delphi	P (%)	(n)	Survey	P (%)	(n)
i.	Gender	Males	71	(12)	Males	58	(114)
		Females	29	(5)	Females	42	(42)
ii.	Age (yrs.)	30 -39	5.9	(1)	21-35	1.5	(3)
		40 - 49	47.1	(8)	26 -30	14.6	(29)
		50 -59	47.1	(8)	31-35	29.3	(58)
					36 - 40	33.3	(66)
					≥ 41	21.2	(42)
iii.	Marital status	Single	12	(2)	Single	38	(76)
		Married	88	(15)	Married	112	(112)
		Divorced	0	(0)	Divorced	10	(1)
iv.	Educational qualification	Master's	76.5	(13)	Bachelors'	82.8	(162)
		PhD	23.5	(4)	Master's	16.2	(32)
					Other (Diploma)	1	(2)
v.	Occupation	Educators	70.6	(12)	All Teachers	100	(198)
		C. Des/Eval.	17.6	(3)			
		Inspectorate	11.8	(2)			
vi.	Position held at work	Lecturer	29.4	(5)	Teacher	96	(148)
		Senior Lecturer	23.5	(4)	HOD	4	(50)
			17.6	(3)			

S/N	Variable	Delphi	P (%)	(n)	Survey	P (%)	(n)
		HOD	11.8	(2)			
		C.Des. / Eval.	5.9	(1)			
		Principal	5.9	(1)			
		Snr. Inspector	5.9	(1)			
		Inspector					
vii.	Work Experience	≤10	5.9	(1)	≤10	60.1	(119)
		11 – 20	35.3	(6)	11 – 20	34.8	(69)
	(yrs.)	21 – 30	52.9	(9)	21 – 30	4.5	(9)
		31 – 40	5.9	(1)	31 – 40	5	(1)

Participants in Phase I were 17 (n), while respondents in Phase II were 198 (n) agriculture teachers. Data from demographic variable were analysed using frequencies and percentages. Males outnumbered females in both the Delphi and survey phase, with 12 (70.6%) and 114 (58%) who participated in Phase I and Phase II, respectively. In Phase I, only 5 female (29.4%) were recorded, and 84 (42%) in Phase II. Amongst these, 94 (2%) in Phase I were primarily over 40 years old, older than respondents in Phase II, mostly between the ages of 36 and 40 (33%). In the two-round modified Delphi technique, eight fell within the age bracket of 40 to 49 years (47%), another eight were within the age bracket of 50 to 59 years (47.1%), and 1 was in the 30 to 39 years (6%). However, 2% (n=3) were between the ages of 21 and 25, 15% (n=29) were between 26 and 30, 29% (n=58) were between 31 and 35, 33% (n=66) between the ages of 36 and 40, and 21% (n=42) were over the age of 41. The majority (n=15) of participants were married in Phase I and 2 were single (12%). In Phase II, 112 were married (57%), 76 were single (38%), and 1 was divorced (10%).

Findings also revealed that all participants in Phase I had a postgraduate degree, whereas respondents (n=163) in Phase II (n=163) had undergraduate degree, with13 (77%) had Master's Degree in Agricultural Education and 4 (24%) had a PhD in Agricultural Education (Phase I). In Phase II, 122 respondents (83%) hold Bachelor's Degree in Agricultural Education and 32 (16%) had Master's Degree in Agricultural Education. Only two (1%) had a Diploma in Agricultural Education. Experts who participated in Phase I were mostly educators (n= 12, 71%), three curriculum designers and/or evaluators (18%), and only 2 were inspectorate (12%). Amongst these, were 5 lecturers (29.4%), 4 senior lecturers (23.5%), 3 Heads of Departments (17.6%), 1 principal of a vocational institution (5.9%), 1 senior inspector (5.9%), 1 inspector (5.9%) and 2 curriculum designers/evaluators (11.8 %). Participants in Phase II were all secondary agriculture teachers (n= 198; 100%). In Phase II, 148 were ordinary teachers (96%) and 4 were heads of departments (4%). Phase I also reveals that 9 (53%) had work experience of 21 to 30 years, six (35%) had w 11 to 20 years, 1 (6%) was in the range 1 to 10 years, and 1 other in the range 31 to 40 years (6%). However, 119 had less than 10 years of experience (60%), and 69 had between 11 and 20 years of experience (35%).

Findings – Phase I Two-rounds Modified Delphi Technique

Round I Findings - Modified Delphi Technique

Round I questionnaire (HAECCSQ 1) is a list of fourteen (17) sub-dimensions (items) on assessment strategies derived from literature review listed under each category of skills, namely: i. Life & Career Skills **(LCS)**; ii. Learning & Innovative Skills **(LIS)**; and iii. Information, Media &Technology Skills **(IMTS).** This round determined which methods can best be used to assess the development of those skills in agricultural education graduates in Eswatini. Participants were asked to indicate on a numeral scale of 1 (*Very Low Priority*) to 5 (*Very High Priority*) the assessment methods that could be prioritised.

Table 3:

Assessment Methods Presented and Rated by Participants in Round 1 (n=17)

Assessment Strategy	**Panel Rating**			
	% 4-5	**IQR**	**Median**	**Decision**
A. LCS				
1. Summative	100	1	4	Endorsed
2. Diagnostic	94.1	1	4	Endorsed
3. Placement	88.2	1	4	Endorsed
4. "21st Century Learning and Innovation Skills" scale	82.4	1	4	Endorsed
5. Performance- based	82.3	1	5	Endorsed
6. Formative	76.4	1	4	Escalated to Round II
7. Portfolio	70.6	2	4	Escalated to Round II
8. Project	70.6	2	4	Escalated to Round II
9. Standardised	64.7	2	4	Escalated to Round II
10. Self-reported measures	58.8	2	4	Escalated to Round II
11. Observational Measures	58.8	2	4	Escalated to Round II
12, Global Rating Scales	53.0	3	4	Escalated to Round II
13. The Torrance Tests of Creativity	52.9	1	4	Escalated to Round II
14. Journal	47.0	3	3	Rejected
B. LIS				
15. Performance- based	94.1	1	5	Endorsed
16. Formative	94.1	1	4	Endorsed
17. Summative	94.1	1	4	Endorsed
18. Diagnostic	94.1	1	4	Endorsed
19. Self-reported measures	76.5	2	4	Escalated to Round II
20. Project	76.4	2	5	Escalated to Round II
21. Portfolio	70.5	2	5	Escalated to Round II
22. Observational Measures	64.7	2	4	Escalated to Round II

Assessment Strategy	Panel Rating			
	% 4-5	IQR	Median	Decision
23. Journal	58.8	2	4	Escalated to Round II
24. Global Rating Scales	52.9	2	4	Escalated to Round II
25. The Torrance Tests of Creativity	52.9	2	4	Escalated to Round II
C. IMTS				
26. Summative	94.1	1	4	Endorsed
27. Performance- based	88.2	1	5	Endorsed
28. Formative	88.2	1	4	Endorsed
29. Placement	88.2	1	4	Endorsed
30. Diagnostic	88.2	1	4	Endorsed
31. Project	76.5	2	4	Escalated to Round II
32. Portfolio	76.4	1	4	Escalated to Round II
32. Self-reported measures	70.6	2	4	Escalated to Round II
33."21st Century Learning and Innovation Skills" scale	64.7	2	5	Escalated to Round II
34. Global Rating Scales	53.0	3	4	Escalated to Round II
35. Journal	52.9	2	4	Escalated to Round II
36. Standardised	52.9	2	4	Escalated to Round II
37. The Torrance Tests of Creativity	47.0	2	3	Rejected
38. Observational Measures	47.0	2	3	Rejected

Round I Cut-off: ≥80%Consensus Rate; ≤ 1 IQR: and ≥ 4 Median [Endorsed]: ≤80% 4-5 and IQR ≥2 and Median < 4 [Escalated to Round II]: and ≤50% 4-5 and IQR ≥2 and Median < 4 [Rejected]

Based on consensus criteria (Table 1), five assessment methods met the 80% inclusion rate under **LCS** category in Round I which included: "*Summative*" [P=100%; IQR=1; Median 5], *"Diagnostic"* [P=94.1%; IQR=1; Median 4], *"Diagnostic"* [P=94.1%; IQR=1; Median 4] and others. Assessment methods such as *"Formative"* [P=76.4%; IQR=2; Median 4], *"Portfolio"* [P=70.6%; IQR=2; Median 4], *"Standardised"* [P=64.7%; IQR=2; Median 4] and others could not attain the required consensus and were escalated to Round II. One method *"Journal"* in this category was rejected. Two methods attained the required consensus under **LIS** category: *"Performance-based"* [P=94.1%; IQR=1; Median 5] and *"Formative"* [P=94.1%; IQR=1; Median 5], *"Summative"* [P=94.1%; IQR=1; Median 4]. Seven methods were escalated to Round II: amongst others: "*Self-reported measures"* [P=76.5%; IQR=2; Median 4], "*Project"* [P=76.4%; IQR=1; Median 5], *"Global Rating Scales"* [P=52.9%; IQR=2; Median 4]. No method was rejected in this category. Five assessment methods under the **IMTS** category reached desired consensus in the first round which included: "*Summative*" [P=94.1%; IQR=1; Median 4], *"Performance-based"* [P=88.2%; IQR=1; Median 5], *"Formative"* [P=88.2%; IQR=1; Median 4]. Seven were escalated to Round II including: "*Project*" [P=76.4%; IQR=1; Median 4], *"Self-Reported Measures"* [P= 70.6 %; IQR=2; Median 4], *"Global Rating Scale"* [P=53.0%; IQR=3; Median 4]. The "*Torrence Tests of Creativity"* [P=47.0%; IQR=2; Median 3] and "*Observational Measures"* [P=47%; IQR=2; Median 3] were rejected.

The summary of items endorsed in Round 1 under **LCS** are Summative; Diagnostic; Placement; "21st Century Learning and Innovation Skills" scale and Performance- based assessment. Under **LIS** are Performance- based; Formative; Summative; and Diagnostic; and under **IMTS** are Summative; Performance- based; Formative; and Placement Assessment. Items escalated to Round 2 included Formative; Portfolio; Project; Standardised; Self-reported measures; Observational Measures; Global Rating Scales; and The Torrance Tests of Creativity under **LCS**. Under **LIS** are Self-reported measures; Project; Portfolio; Observational Measures; Journal; Global Rating Scales and The Torrance Tests of Creativity. Under **IMTS** are Project; Portfolio; Self-reported measures; "21st Century Learning and Innovation Skills" scale; Global Rating Scales; Journal and Standardised Assessments. Those rejected include Journal Assessment under **LCS**, The Torrance Tests of Creativity and Observational Measures under **IMTS**.

HAECCSQ 1 also had a section to further suggest other assessment methods deemed important for inclusion and the rationale. In this section, 2 new items were generated by experts as shown in Table 4 with rationale. New methods suggested by experts in all categories were *"Peer"* and *"Criterion-Referenced Assessment"*. These new methods, together with items that met the "*Escalation to Round 2*" criteria were retained to be included in the Round 2 questionnaire (HAECCSQ 2) for rating and re-rating by experts, respectively.

Table 4:

New Assessment Methods Suggested by Participants in Round 1 for Inclusion in the 2nd Round (N=17)

Assessment Strategy	Rationale
LCS; LIS; and **IMTS**	
1. Peer Assessment	*Very important in helping students develop lifelong skills in assessing and providing feedback to others. They will also develop skills that will help enable them to assess themselves and improve.*
2.Criterion-Referenced	*Assessing students based on how they are progressing towards mastery of a specific skill, rather than comparing their performance against others should be encouraged if they are to gain 21st century skills. This method provides focus and intentional teaching.*

Round II Findings - Modified Delphi Technique

Seventeen experts participated since a response rate of 85% was achieved in Round I (Table 5). Participants were given HAECCSQ 2 where items were further re-rated and newer items suggested by experts were rated again, on a numeral scale of 1 (*Very Low Priority*) to 5 *(Very High Priority*). Other items were endorsed for inclusion and those that could not reached consensus were automatically rejected.

Table 5:

Assessment Methods Prioritised by Participants in Round 1 for Inclusion in 2nd Round (n=17)

Assessment Method	Panel Rating			
	% 4-5	IQR	Median	Decision
A. LCS				
1. Formative	88.2	1	4	Endorsed
2. Peer	82.3	1	4	Endorsed
3. Self-reported measures	76.4	1	4	Rejected
4. Criterion Referenced	70.6	2	4	Rejected
5. Portfolio	70.5	1	4	Rejected
6. Project	70.5	1	4	Rejected
8. Standardised	64.7	1	4	Rejected
9. Global Rating Scales	58.8	2	4	Rejected
10. Observational Measures	58.6	2	4	Rejected
11. Torrance Tests of Creativity	58.6	1	4	Rejected
B. LIS				
12. Project	88.2	1	5	Endorsed
13. Observational Measures	82.4	1	4	Endorsed
14. Portfolio	82.3	1	5	Endorsed
15. Peer	82.3	1	4	Endorsed
16. Criterion Referenced	76.5	2	4	Rejected
17. Journal	70.6	2	4	Rejected
18. Global Rating Scales	64.7	2	4	Rejected
19. Torrance Tests of Creativity	64.7	2	4	Rejected
20. Self-reported measures	64.7	2	4	Rejected
C. IMTS				
21."21st Century Learning and Innovation Skills" scale	94.1	1	5	Endorsed
22. Self-reported measures	79.5	1	4	Endorsed
23.Criterion Referenced	76.5	2	4	Rejected
24. Project	70.6	1	5	Rejected
25. Portfolio	70.6	2	4	Rejected
26. Peer	66.4	1	4	Rejected
27. Global Rating Scales	64.7	1	4	Rejected
28. Journal	64.7	2	4	Rejected
29. Standardised	64.7	1	4	Rejected

Round I Cut-off: ≥80%Consensus Rate; ≤ 1 IQR: and ≥ 4 Median score [Endorsed]: ≤80% 4-5 and IQR ≥2 and below [Rejected]

Ten items under the **LCS** category entered into this round and two met the 80% consensus rate: *"Formative"* and *"Peer Assessment,* consequently endorsed for inclusion. Other assessment methods did not reach consensus in this category (rejected). Nine items entered under the **LIS** category, and four methods including *"Project"*, *"Portfolio"* reached consensus. Assessment strategies could not reach consensus (rejected). Amongst the 9 items, under the **IMTS** category**,** 2 methods reached the desired consensus: *"21st Century Learning and Innovation Skills scale"* and *"Self-Reported Measures"*. All others were rejected.

Summary of Phase I Findings on Dimension of Assessment Methods for 21st Century Skills Development in Higher Agricultural Education Curriculum in Eswatini

Three assessment methods were common to all 21st Century Skills categories: *"Summative", "Diagnostic"* and *"Formative Assessment".*

Findings - Survey (Phase II)

This section presents information on assessment methods to be used in the higher agriculture education curriculum for 21st century skills development in Eswatini. In deciding on the items of high importance in HAECCSQ 3, the real limits of mean ranges for decision making were: Item with a mean value of 5.00 was regarded as of Strong Agreement; 4.00 – 4.99 = Agreement; 3.00 – 3.99 = Slightly Agree; 2.00 – 2.99 = Disagreement and ≤ 1.99 = Strong Disagreement. Table 7 shows the dimension and based on the agreement level criteria, all agriculture teachers were in agreement with the 20 assessment methods identified by experts in Phase I.

Table 7:

Assessment Methods for 21st Century Skills Development in Eswatini (n=198)

	Assessment Method	M	SD	Interpretation
A.	**LCS**			
1.	Performance-based	4.38	0.70	Agreement
2.	21st Century Learning and Innovation Skills scale	4.21	0.77	Agreement
3.	Diagnostic	4.18	0.63	Agreement
4.	Summative	4.17	0.80	Agreement
5.	Formative	4.11	0.80	Agreement
6.	Placement	4.09	0.74	Agreement
B.	**LIS**			
7.	Diagnostic	4.26	0.67	Agreement
8.	Project	4.20	0.72	Agreement
9.	Formative	4.17	0.64	Agreement
10.	Summative	4.16	0.71	Agreement
11.	Performance-based	4.14	0.86	Agreement
12.	Portfolio	4.10	0.74	Agreement
13.	Observation	4.10	0.76	Agreement
C.	**IMTS**			
14.	Performance-based	4.30	0.67	Agreement
15.	Diagnostic	4.21	0.75	Agreement
16.	Summative	4.19	0.71	Agreement
17.	Placement	4.16	0.67	Agreement

	Assessment Method	M	SD	Interpretation
18.	Self-reported measures	4.14	0.82	Agreement
19.	21st Century Learning and Innovation Skills scale	4.11	0.77	Agreement
20.	Formative	4.09	0.74	Agreement
	Average	**4.23**	**0.71**	**Agreement**

Agreement Level Scale: 1= Strongly Disagree; 2= Disagree; 3=Slightly Agree; 4= Agree; 5=Strongly Agree. Cut-off Point: Mean value of 5.00 =Strong Agreement; 4.00 – 4.99 = Agreement; 3.00 – 3.99 = Slightly Agree; 2.00 – 2.99 = Disagreement and ≤ 1.99 = Strong Disagreement

Table 7 shows mean values of 4.38 to 3.94 with standard deviation values ranging from 0.92 to 0.63. The table also shows the dimension mean [4.23] and standard deviation [0.71]. The 3 most highly rated methods under **LCS** were: *"Performance-based"* [M=4.38; SD=0.70], "*21st Century Learning and Innovation Skills Scale"* [M=4.21; SD=0.77] and *"Diagnostic"* [M=4.18; SD=0.63]. Under the **LIS** category were: "*Diagnostic"* [M=4.26; SD=0.67], "*Project"* [M=4.20; SD=0.72] and *"Formative"* [M=4.17; SD=0.64]. Under the **IMTS** category, were "*Performance-based*" [M=4.30; SD=0.67], "*Diagnostic*" [M=4.21; SD=0.75] and "*Summative*" [M=4.30; SD=0.70]. The most common method revealed to be suitable to assess development of all 3 categories of skills was *"Diagnostic"*. Standard deviations of all methods from respondents were below 1.00. This indicated that responses were not far from the mean. This added value to the reliability of the mean.

Discussion

Findings of study revealed ten assessment methods to be used in higher agricultural education curriculum for 21st century skills development in Eswatini. Experts in Phase I first identified these and later confirmed by secondary and high school agriculture teachers in Eswatini. These include *performance- based, diagnostic, summative* and *formative assessment methods* which were common to all categories of skills; *21st Century Learning and Innovation Skills scale* and *Placement* specific to **LCS**; *Observation* and *Portfolio assessment methods* specific to the **LIS** category; and *21st Century Learning and Innovation Skills scale, Placement* and *self-reported measures* specific to **IMTS** category. Although academics argue that measuring and assessing 21st century skills is difficult, the study findings are consistent with findings reported by Lai and Viering (2021), who reported that skills such as critical thinking, creativity, collaboration, motivation, and metacognition can be assessed using methods such as formative and summative measures, among others. Ketterlin-Geller (2011) also points out the importance of formative and summative assessments. In accordance with the study findings, formative and summative assessments can still be employed in the assessment of 21st century abilities (Saavedra & Opfer, 2012), albeit some skills are too subjective and mysterious to be quantified objectively. Furthermore, as stated by Gardner's ARIA Committee (2009), assessments should allow students to demonstrate what they can achieve by completing projects addressing the full spectrum of learning goals. The study's findings share this sentiment by suggesting the use of performance-based and diagnostic assessment methods to assess students' development of 21st century skills. Agricultural education is often a project-based, hands-on curriculum that covers a wide range of agriculture and agriculture-related topics by leveraging local resources and industries, making course material practical and relevant to students (Blum, 1996), hence assessment methods allowing display of performance on tasks are very critical. The study findings further indicated the use of multiple methods for assessing three categories of 21st century abilities, a viewpoint supported by Redecker and Johannessen (2013) who argue that

diverse assessment tools are required because a single assessment instrument cannot reach the intended outcomes. Moreover, Franklin, Kader, Mewborn, Perry, and Scheaffer (2007) agreed and proposed that different forms of assessments such as journal, portfolio, project, self-assessment, and peer-assessment can also be used to assess critical thinking and problem-solving skills. The affirmations are consistent with the study findings. Contrary to the study findings, however, measuring scales such as "California Critical Thinking Tendency Scale" and "Problem Solving Inventory" used to assess 21st century skills suggested in literature were rejected by experts in the current study. It can, however, be speculated that these were rejected because the concept of 21st century skills and how to assesses them is still new, especially in developing countries like Eswatini. Efforts should be expedited across the country to educate agricultural educators in the teaching and assessment of 21st century skills.

Conclusions and Recommendations

The study showed that incorporating 21st century skill development in agricultural education should be a simple transfer if assessment skills attainment is prioritised. The current study identified performance-based; diagnostic; formative; summative assessment amongst others that can be employed to assess the development of 21st century skills in agricultural education graduates, hence incorporating them in the Higher Agricultural Education Curriculum in Eswatini for 21st century skills development is imperative. Moreover, a need showed for agricultural educators in the country to become more informed about other emerging methodologies for assessing 21st century skills in their future graduates.

It is recommended, therefore that:

i. Lecturers in the Department of Agricultural Education and Extension, UNESWA, use the study's findings to update and amend their current assessment practices.
ii. The agricultural education lecturers should hold professional development activities aimed at helping themselves become more informed and competent in assessing 21st century skills.
iii. A study on "Capacity Building Needs of Agriculture Education Lecturers on the Effective Use of 21st Century Teaching Assessment Strategies at the University of Eswatini" is also recommended for further investigation.

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Conflict of Interest

We declare that there is no conflict of interests regarding the publication of the paper and it is our original contribution.

Authors' contributions

The contributions of all authors in this paper is as follows:

Gule Zanele Muntu: Conception/design, development of data collection instrument, analysis, interpretation of data, revised manuscript (50%).

Professor M.P Dlamini: Conception/design, data collection, analysis, interpretation of data, editing of drafts (30%).

Professor E.A. Alademerin: Conception/design, data collection, analysis, interpretation of data, editing and first draft (20%).

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